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GUIDELINE ON STRUCTURED MOBILITY

MOBI-US Consortuim

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Content

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Preface

The objective of this guideline is to support the networking partners of the MOBI-US EIT RawMaterials project with a set of background materials and advices in order to help them prepare well-established mobility pathways for students studying for their master programmes and in continuation to implement them after the end of this project.

The guideline – in accordance with the MOBI-US project proposal – consists of five chapters and gives background, recommendations and best practices examples in the following topics:

Chapter 1: General framework of organization of structured mobilities as joint education programmes and especially mobility windows within the European Higher Education Area (EHEA). This chapter explains the most important terms and concepts related to structured mobilities. The chapter would be useful to those ones who are still not very familiar with organization of student mobilities and joint education programmes.

Chapter 2: Best practices on organization, establishment and management of joint education programmes. This chapter is based on the introduction of ten critical requirements for a successful and sustainable joint programme. The recommendations are complemented by best practices and personal comments of an expert in this field.

Chapter 3: This chapter summarizes the practical organizational and management issues which should be set up and maintained for student mobilities at a university taking part in the mobility network. Practical recommendations are complemented by best practices and links to recommended background materials.

Chapter 4: Industry trends and policy perceptions in the ESEE region concerning the raw materials sector. While the first three chapters have a general character and focus on organizational and management issues of structured mobility, this chapter gives background information to review the content of the participating master programmes, giving a brief overview of trends and policy perceptions in the raw materials sector of the ESEE region.

Chapter 5: This chapter gives a more practical tool for a review of the participating master programmes, providing insights on the skills needs of industry and making the bridge between education and industry in the raw materials sector. The chapter is based on the available results of the recently ongoing INTERMIN project, introducing a new qualifications framework, a skill and competence catalogue for raw materials-related education programmes.

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The guideline in this form provides essential information from different aspects for preparation of mobility pathways and a good implementation of MOBI-US project.

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1. Chapter 1: Structured mobility concepts in the EHEA

The present document is a summary of detailed studies produced by other Programs. These reports are open to the public and are encouraged to be consulted as well. To keep the discussion in line with the aims and geographical context of MOBI-US Project, the information presented hereby is focused on joint programs within Europe only. In general, it can be said that the guidelines implemented in Europe through the Erasmus program has improved the attractiveness of European institutions as partners overseas. For the interested reader, the literature referred hereby provides insights on transcontinental joint program initiatives.

1.1. Background

The European Higher Education Area (EHEA) was established with the goals of promoting more comparable, compatible and coherent higher education systems in Europe. Unofficially referred to as the “Bologna Process”, it was established in 1999. Interestingly, this is a voluntary process at European level but has been adopted by all EU member states, reflecting the interest of adopting standardized education throughout Europe and facilitating the creation of international joint programmes.

Indeed, as documented in ”Joint Programmes from A to Z”, ”During the Bologna conference in Berlin in 2003, ministers explicitly agreed on supporting the development and quality assurance of integrated curricula leading to joint degrees (since these) support various Bologna action lines, such as student mobility, joint curriculum development and joint quality assurance.” [1]

Within this context, the curriculum has to be jointly developed, taking care of the professional profile to be created, the competences required for that particular professional profile, the definition of learning outcomes of the whole programme, the workload to be attributed to the single teaching units and modules for the achievement of the identified learning outcomes.[2]

Consequently, according to the Bologna Process Implementation Report 2012 [3], several of the participating European countries have actively modified their legislation to encourage joint programs, resulting in an increasing number of students in these programmes.

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The European Association for Quality Assurance in Higher Education (ENQA) was established in 2004 with the aim to promote European cooperation in the field of quality assurance in higher education.
The European Standards and Guidelines (ESG) were developed as part of the Bologna Process and adopted by European ministers of higher education in 2005. The ESG consist of three parts, covering:

- internal quality assurance;
- external quality assurance;
- external reviews by quality assurance agencies.

A revised version of the ESG, approved by the Bologna Follow-up Group (BFUG), was presented at the Bologna meeting in Yerevan in May 2015. [1]

To specifically aid with the establishment and implementation of joint programmes, the Erasmus Mundus Programme (EMP) was started in 2003 and continued until 2008. The first version of Erasmus initiative was proven quite successful and according to “How to Manage Joint Study Programmes?”, it “triggered an essential change in the philosophy of JP creation and administration. The Erasmus Mundus Programme focuses predominantly on the concept of ’consortia’ as well as on the concept of ’integration’ to be applied to the curricular aspects as well as to the administration and management issues of a JP.” [2] The EU continued its support for international joint programmes through the Erasmus+ programme in 2014-2020, with an increased budget as compared to the Erasmus Mundus programme. [1]

The concept of joint programmes as a means for internationalisation has spread globally, probably in response to European developments. For instance, the Institute of International Education's Transatlantic Study [7] pointed out that US institutions are most likely to have joint programmes with European partners than with institutions in any other region. Another main finding of this report was that among transatlantic partnerships, joint programmes leading to the awarding of two or more diplomas (double/multiple degree programmes) are much more common than joint programmes leading to one diploma (joint degree programmes), most probably due to legal and administrative challenges related to the awarding of a joint diploma. [1]

It is also worth mentioning that, although the European Union supports the development of joint programs via the aforementioned cooperation programs, and the European Commission does not seek to influence the educational offering through legislative power and funding scheme rules on e.g., admission, selection and tuition fees remain decisions at the national level. As stated in ”Joint Programmes from A to Z” [1], the European Union has no intention to impose legislation, but rather: ”the European Union influences higher education policy through political cooperation.” And it continues: “Since the adoption of the Lisbon Strategy in 2000, political cooperation in

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education has been strengthened – first by the 'Education and Training 2010' work programme, followed by the strategy for European cooperation in education and training 'ET 2020'. This cooperation has led to the formulation of common targets and initiatives, which are supported by a number of funding programmes, such as the Lifelong Learning Programme 2007-13, Erasmus Mundus 2009-13 and the Erasmus+ programme that has replaced all the existing initiatives in 2014. Funding bodies, such as the European Commission, have no legislative power within the educational sector." [1]

The European Commission provides information and a database on regulated professions within the EU internal market (Directive 2005/36/EC), as well as updates on current directives and harmonisation measures.

1.2. Guidelines

To implement joint programs successfully, there are existing guidelines suggested by the European Union on which international educational cooperation can be based. Among the purposes of the Bologna process is the introduction of transparency instruments to support student mobility, such as the European Credit Transfer System (ECTS) and the Diploma Supplement (DS).

In the first place, it is important to recognize that European-level actions are meant to foster cooperation but do not supersede local legislation. As stated in "Joint Programmes from A to Z" [1]: "the legal power related to higher education policy and the implementation of joint programmes lies within the national or sub-national legislation and applies also to international cooperation activities. It is therefore important to first and foremost carefully check national regulations and not only European regulation. Higher education policy is developed and implemented at the national level by the relevant ministry of education or science."

Concerning the integration of the organisation and management of JPs, Erasmus Mundus focuses on the integration of student administration procedures (application, admission, selection and enrolment procedures), as well as in the definition of a common tuition policy among the consortium participants and in the assurance of providing each student the same level of services. The basic assumption behind this requirement is that students enrolled in a JP will acquire the same learning outcomes regardless of the institution where they start the programme, and they should therefore benefit from the same level of services and should pay the same tuition fee. [2]

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In addition, the Convention on the Recognition of Qualifications concerning Higher Education in the European Region (The Lisbon Recognition Convention - LRC) states that recognition is "a formal acknowledgement by a competent authority of the value of a foreign educational qualification with a view to access to educational and/or employment activities" [4].

Finally, the ministers of education of the European Higher Education Area (EHEA) recommended the use of the European Area of Recognition Manual for higher education institutions (EAR HEI) [5], including information on recognition of qualifications awarded by joint programmes.

1.3. Definitions

The Erasmus Mundus Programme has also set an explanation of the most commonly used terminology, with particular reference to the final delivery of the diploma, providing a definition for the terms "double degree", "multiple degree" and "joint degree". However, following the Erasmus Mundus philosophy, whatever the final diploma delivered, the consortia should implement a jointly planned and developed programme, including a strong integration of both curricula and organisation.

In the present section, a set of relevant definitions for Joint Programs are compiled and reproduced verbatim from the "Joint Programmes from A to Z" guide [1]. This is followed by two sub-sections dedicated specifically to define the concepts of "***mobility windows***" and "***project work courses***" since these are concepts that require particular attention in the context of the MOBI-US Project.

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List of Definitions Relevant for Joint Programmes [1]

Joint programme

A joint programme is a programme offered jointly by several higher education institutions. These institutions can be located either in the same country or in different countries. A joint programme does not necessarily lead to a joint degree. It is only one of the possible awards. After completion of a joint programme a graduate may be awarded: a single national qualification, a double (or other multiple) qualification or a joint qualification.
Joint programmes have all or at least some of the following characteristics:

- The programmes are jointly developed and/or approved by several institutions;
- Students from each participating institution study parts of the programme at other institutions; The students' stays at the participating institutions are of comparable length;
- Periods of study and exams passed at the partner institution(s) are fully and automatically recognised;
- Professors of each participating institution also teach at the other institutions, jointly work out the curriculum, and form joint admission and examination commissions;
- After completion of the full programme, the student either obtains the national degrees of each participating institution or a degree awarded jointly by them.

Joint degree

A joint degree may be issued as:

- a joint diploma in addition to one or more national diplomas;
- a joint diploma issued by the institutions offering the study programme in question without being accompanied by any national diploma;
- one or more national diplomas officially issued as the only attestation of the joint qualification in question.

The European Consortium for Accreditation (ECA) makes three remarks on these three points, since the Recommendation has become slightly outdated by now. ECA [8] explains that:

- it is unlikely that both the joint and the national degree are acknowledged as the national higher education qualification;
- the second part of the definition of the Recommendation is now commonly understood as a joint degree;
- the third part of the definition describes the situation which is currently considered as a multiple degree.

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Joint diploma
A document issued on successful completion of the programme, indicating that the degree holder has obtained a joint degree.

Accreditation
A formal and independent decision indicating that a programme and/or an institution meet(s) certain predefined quality standards.'

Recognition
A formal acknowledgement by a competent authority of the value of a foreign educational qualification with a view to access to educational and/or employment activities.'

European Diploma Supplement
A document attached to a higher education diploma aimed at improving transparency and facilitating recognition. It describes the nature, level, context, content and status of the studies that were successfully completed by the individual named on the original diploma to which this supplement is appended.
The tool was initiated by UNESCO and jointly revised by UNESCO, the European Commission and the Council of Europe. Graduates in all the countries taking part in the Bologna Process are entitled to automatically receive the Diploma Supplement in a 'major' European language.

European Qualifications Framework, EQF
The European Qualifications Framework is an EU initiative, which acts as a translation device to make national qualifications more readable across Europe. The EQF aims to relate national qualifications systems of different countries to a common European reference framework. The EQF applies to all types of education, training and qualifications, from school education to academic, professional and vocational. Levels of national qualifications are placed at one of the central reference levels, ranging from basic (Level 1) to advanced (Level 8).

The higher education bachelor-level cycle corresponds to the learning outcomes for EQF level 5-6. The master-level cycle corresponds to the learning outcomes for EQF level 7 and the doctoral-level cycle to EQF level 8.

The Framework for Qualifications in the EHEA comprises three cycles, generic descriptors for each cycle, based on learning outcomes and competences, and credit ranges in the first and second cycles. The first, bachelor-level, cycle ranges from 180-240 ECTS credits and the second, master-level, cycle from 90-120 ECTS credits.

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Mobility windows

A concept worth mentioning in particular is that of "mobility windows (MWs)", defined by the Academic Cooperation Association as "*a period of time reserved for international student mobility that is embedded into the curriculum of a study program.*" In other words, the concept of a mobility window refers to a period of time during the academic year in which specific courses in the existing curricula can be offered to external students, or where the university's own students have the opportunity to take credits abroad.

It is of particular importance to emphasize that the concept of mobility widows implies that such courses are part of the regular study curriculum and are thus not designed specifically for an exchange program. This is likely the main difference with other arrangements for exchange studies, where courses are planned specifically having in mind the intended learning outcomes of the international program.

By offering a mobility window, the resources of a university are more efficiently used, while allowing the possibility to expand the number of course participants, since each mobility window can be offered to multiple exchange partners. Another difference with the regular exchange models, for example through Erasmus exchange scholarships, is that the students are not completely in charge of choosing courses in an independent manner, but are rather directed towards course modules that are deemed relevant for their specific professional profile and his/her program's intellectual learning outcomes. This may also facilitate administrative aspects since students are received from and sent to pre-approved programs into well-defined courses.

Certainly, the establishment of mobility windows involve some practical challenges. In the first place, it is evident that all the courses in the mobility window must be offered in a common language (likely English) and that there is a compatibility between the home university's own program and that of the host institution. A further challenge is to schedule of the courses in the mobility window in the same time periods and furthermore, in times where students from other universities have the possibility to attend. For this reason, and even though flexibility is one of the attractive characteristics of this exchange model, it is important to find suitable partners to offer and receive students within the available mobility windows.

One example of the structured exchange concept using mobility windows is the European Minerals and Recycling Engineering Course (EMREC). As seen in Figure 1.1, EMREC courses are based on the Sustainable Metals Processing program offered by Aalto University (Finland) and the Geo-engineering Resources program in TU Delft (the Netherlands). To allow the integration of students from both universities as a study group, each program has defined a mobility window at

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different times of the academic year, with courses relevant for both programs. As seen in Figure 1.1, the mobility window concept was **designed to offer courses with content that are not offered in the student's respective home universities**. In the case of Aalto University, the courses are focused on unit operations and processes for metallurgical engineering, including courses dealing with recycling and circular economy. On the other hand, TU Delft's mobility window is based on financial engineering and material science of metals, aspects that are a specialty in this university.

The exchange of students is thus structured in a way that all students begin in their home universities and, as the first period begins, they are offered the opportunity to visit the partner university (with additional support provided to apply for international exchange scholarships). Those students interested in the exchange, can then visit Aalto University during the second semester and TU Delft during the third. As the mobility windows are embedded in the curriculum, no major efforts are required, and it is not detrimental if students decide to continue their entire education in their home university. In the end, the students return to their home universities to carry on thesis work according to internal regulations and are granted the degree of their home university, along with a supplementary diploma stating their participation in the structured exchange. It is worth noting that the Master's degree programs in both Aalto University and TU Delft are offered entirely in English, an aspect which facilitates the choice of courses in the mobility window.

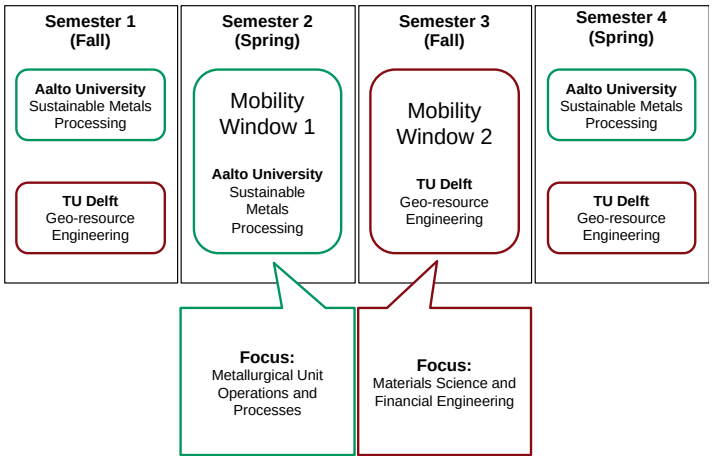

Figure 1.1. Mobility windows concept in the European Minerals and Recycling Engineering Course (EMREC)

Understandably, the concept of mobility windows has gained relevance in recent years as it provides a flexible arrangement of educational programs to allow student exchange. These

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windows can be programmed as optional or mandatory (Figure 1.2), depending on how strong a commitment for internationalization is required by the program and can thus offer the possibility to create a wider network of exchange programs beyond the limitations of strictly defined multiple degree programs. Indeed, mobility windows can also represent the exchange modules in a multiple degree program with mandatory exchange modules, but the principal idea is that these modules are built on already existing courses in the established educational programs.

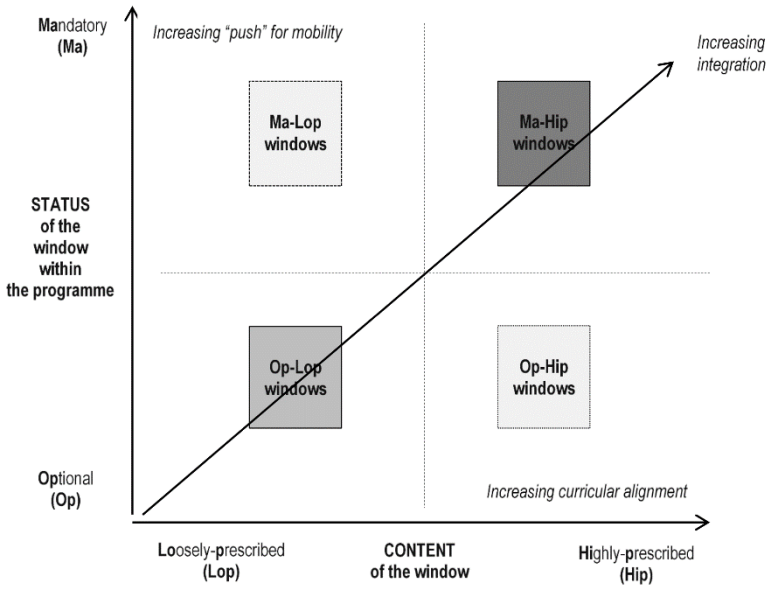

Figure 1.2. Status possibilities for mobility windows in an educational program

Project work-based courses

The last concept worth defining in the present Chapter is that of "**project work-based courses**". The attractiveness in the implementation of project work as a teaching method is the opportunity it offers to move from traditional lecture-based teaching structures into a more interactive type of learning. Courses based on project work are also flexible enough to incorporate aspects of soft-skills development and non-technical content. When properly directed, project work can be used for the development of entrepreneurial mindset skills, for example.

As discussed in the work of Hyppönen and Lindén [5], project work offers the opportunity to combine theoretical knowledge with practical action. Independently of the nature of the project, students have the opportunity to learn the topic as a comprehensive process, that is, from

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ideation to realization. If project work is carried out in teams, organizational skills are also required, as each member needs to understand their roles and take ownership of their expected contribution.

From the perspective of the educator, project work-based studies require good planning and the continuous intervention of the teacher in a mentoring role. It should first be decided whether the projects used as case studies will be provided to the students or if the students should define them. The latter option can be considered as part of the learning outcomes of the course itself. In courses interested on entrepreneurial mindset development, it should be encouraged that students define project topics after market surveys and consultations with relevant stakeholders, for example. The teacher should also choose whether it is necessary to designate roles or allow self-organization of a team. This is can become a critical aspect since students do not always have the sufficient experience to organize effectively. It is thus the teacher's responsibility to guide students, particularly during the early stages of their work. As project work develops, it becomes necessary to provide timely and relevant feedback to students, both to foster the learning process and to maintain the motivation of students. The teacher is thus required to keep an open mind to the unique approach and ideas of students and be able to provide constructive criticism, even when dealing with topics that are beyond the educator's own specific area of expertise.

Finally, assessment of project work needs to be carefully planned. Evidently, the assessment of project work cannot be carried out in a similar manner as traditional written examinations, for example. Indeed, in project work studies, the process followed towards the completion of the project is an important factor to be evaluated. With that in mind, even failed projects can fulfill the intended learning outcomes, provided a proper analysis of the reasons of failure and alternative operating methods are identified.
A template for the planning of a course using project work as a teaching tool can be found in Appendix 1 [6].

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1.4. References

[1] JDAZ “Joint Programmes from A to Z – A guide for practitioners” (2015)

[2] JOIMAN Network, “How to manage joint study programmes – Guidelines and Good Practices from the JOIMAN Network” (2010) http://ecahe.eu/w/index.php/How_to_Manage_Joint_Study_Programmes#Source

[3] Education, Audiovisual and Culture Executive Agency “The European Higher Education Area in 2012: Bologna Process Implementation Report” (2012)

[4] ETS No. 165 “Convention on the Recognition of Qualifications concerning Higher Education in the European Region” (1997)

[5] European Commission “The European Recognition Manual for Higher Education Institutions” 2nd Ed. (2016) http://eurorecognition.eu/Manual/EAR%20HEI.pdf

[6] O. Hyppönen, S. Lindén “Handbook for teachers – course structures, teaching methods and assessment” (2009)

[7] Institute of International Education Freie Universitat Berlin “Joint and double degree programs in the Transatlantic context” (2009) https://www.iie.org/Research-and-Insights/Publications/Joint-Degree-Survey-Report-2009

[8] Aerden A. & Reczuska H. “The recognition of qualifications awaeded by joint programmes” (2010) http://ecahe.eu/w/images/4/47/Eca-Publication---the-recognition-of-qualifications-awarded-by-joint-programmes---2010.pdf

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1.5. Appendix 1. Course plan template for project work

Appendix 9

Project work, 6 credits (100 students) Week	Student's work	Indep.	Contact	Group	Workp.	Guid.	Teacher's work	Time (h)
-N	PREPARATION. Students independently familiarise themselves with the given literature and earlier projects. A general picture of the course. Each student can decide how much work they will do before the start of the course, according to their situation.	10					PREPARATION. Thinking about the project topics (same topic for all groups/different topics) (5d). Planning the instructions for the project and the learning day (2d).	50.75
1–12	READING THE MATERIAL INDEPENDENTLY AND INFORMATION GATHERING.	40						
1	CONTACT. Lecture (2h), which discusses the course practices, goals and purpose. Dividing groups and selecting topics. INDEPENDENT STUDYING. Preparation for the lecture and its analysis (2h).	2	2				LECTURE. Giving the lecture and its analysis (2h). Dividing students without groups into groups (2h).	4
2	INDEPENDENT AND GROUP. Starting the project and creating the project plan. The students work both independently (4h) and in groups (2h) related to the project work. The student also writes a learning diary about his studying and learning continuously (2h).	6		2			GUIDANCE. Guiding the groups as required (2h/week). The groups contact the teacher.	2
3–4	INDEPENDENT AND GROUP. Project plans. The students work both independently (2 x 4h) and in groups (2 x 2h) related to the project work. The student also writes a learning diary about his studying and learning continuously (2 x 2h).	12		4			GUIDANCE. Guiding the groups as required (2h/week). The groups contact the teacher.	4
5	INDEPENDENT AND GROUP. Finishing the project plans and giving them in. The students work both independently (12h) and in groups (8h). Group guidance session with the teacher (1h).	12		8		1	GUIDANCE. Reading the project plans of the groups (1h/group) and giving feedback on them for each group (1h/group) (20 groups).	40
6–11	INDEPENDENT AND GROUP. Carrying out the project according to the plan. The students work both independently (6 x 4h) and in groups (6 x 2h) related to the project work. The student also writes a learning diary about his studying and learning continuously (6 x 2h).	36		12			GUIDANCE. Guiding the groups as required (2h/week). he groups contact the teacher.	12
12	FINAL SEMINAR, GIVING IN THE PROJECT FINAL REPORTS.	4	4				SEMINAR. Running the seminar and analysis of feedback.	4
13							CHECKING. Checking the project works of the groups (20 x 1h) and the students' learning diaries (100 x 1h).	120
	Total by working method (h)	122	6	26	0	1	TOTAL (h)	237
	TOTAL (h)	155					TOTAL (d)	33
	TOTAL (credits)	5.8						

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2. Chapter 2. Best practices for joint programs

According to the work of Hofmann & Crosier [1], there is an emphatic need for a "culture of jointness" in which all members of the joint program are considered co-owners with similar input and responsibilities in the program. The "culture of jointness" should be based on the idea that the whole is more than the sum of its parts, thus motivating the cooperation between educational institutions. Hofmann & Crosier thus identify **10 critical points covering the needs of joint programs**. To help with the discussion of best practices, we decided to take these critical points to organize the requirements of joint programs and comment on best practices.

An aspect worth emphasizing in this work is the concept of "shared understanding" which can only be implemented with an agreement on a common language. Most likely, joint programs will adopt English as a basis for communication, but in any case, all parties should be able to agree on a single language of teaching and for the discussion and administration of the program.

To comment on practical aspects regarding these topics, each point includes practical suggestions stemming from the JOIMAN project [2]. The JOIMAN project was developed with the explicit purpose of developing recommendations and good practices for joint programs in the European context. In this project, various relevant aspects on existing joint programs were identified through an extensive survey and the results were compiled in a detailed guideline book. Hereby, the good practice guidelines proposed in the JOIMAN project for joint European programs at the Master's level are compiled and commented.

Finally, to help with the goals of the present document, the discussion on best practices is complemented with comments on how these have been implemented in the European Mining Course (EMC), a triple-degree program offered by Aalto University (Finland), TU Delft (The Netherlands) and RWTH Aachen (Germany). For a more detailed knowledge on best practices, it is highly recommended to consult the references used hereby.

2.1. The 10 critical needs of joint programs

1. A joint degree is a highly complex, coordinated activity of partners. **Cooperation and coordination** are hence crucial for the realization of any joint degree program [1]

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Best practices [2]:

1. *When planning a joint programme, one should **set the criteria for selecting partner**(s) beforehand.*
2. *When setting your criteria for selecting a partner, one should **include administrative aspects** as well. The academic criteria are essential, but not sufficient.*
3. ***Mutual trust** is essential for the development of successful joint programmes, it is therefore recommended to **involve long term collaborative partners** assessed both at academic and administrative level.*

Comment:
In EMC, partners were historically chosen from universities with recognized mining engineering programs whose enrolment numbers were decreasing. Once EMC became a joint program, the partner universities set a program exploiting the complementary strengths of each university for the benefit of the students. In addition, each of the partner universities has administrative support specifically in charge of exchange study programmes.

2. Often, a central coordination structure will not be institutionalized – at least not in terms of infrastructure. In many cases, **coordination will take place mostly in informal cooperative structures**. Hence, the joint degree program – in terms of organization – may be characterized as a collaborative initiative with a central coordination supported and "fed" by two or more universities. These universities in turn will have their own coordination and decision-making structures which may influence the coordination of the network as a whole. Given this complexity, coordination on different levels should be considered and analysed in a transparent way: who takes decisions? When? How? With whom? On what basis? [1]

Best practices [2]:

1. *Clarifying if the implementation of an application procedure managed at consortium level could substitute the regular application procedures applied to each partner's institution.*
2. *When addressing international students from all over the world, it is important to use an online application. The consortium should discuss how to implement and financially and technically support this.*
3. ***Involvement of registrar offices since the development phase** of the programme is important, especially if the institution has no great experience in joint programmes, in order to avoid students being rejected for formal requirements after having been selected by the consortium or by the first enrolment institution.*

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4. *Discussing and harmonising the formal requirements for enrolment ensuring that **students can obtain access to services and to certification** at each institution.*
5. *Discussing in detail the **documentation required by each institution** for enrolment (certificate of previous studies, declarations from the consulates, official translations).*
6. *Mutual trust for enrolment: do not require additional documents at the second enrolment or registration.*
7. *To properly adopt, with statistics carried out at faculty or programme level regularly, the **ECTS grading scale for the conversion of marks**. When this is not possible, the use of converting tables developed ad hoc could be a valid alternative.*
8. *Have a common follow-up tool which enables the centralisation of data, made available to all partners.*

Comment:
In the case of EMC, faculty members of the consortium partners are appointed as Board members of the Federation of European Mining Programs (FEMP) an organization created with the specific purpose of coordination and management of the program. FEMP has internal regulations specifying the aim of the educational programs, roles of the Board members and the decision-making process. FEMP is also in charge of financing the program beyond the resources provided by the universities, in order to keep the program sustainable.

3. In order to ensure that each of the collaborating universities is **willing and ready to support the joint initiative**, several **key preconditions** need to be identified and fulfilled before institutions reach the stage of issuing diplomas and certificates together. Trust between partner institutions will be enhanced through greater knowledge and understanding of specific features, profiles and strengths. [1]

Best practices [2]:

1. *Having selected the partners, before starting the development phase it is important to **be aware of the national situations** of the partners involved and in particular:*
   a. *It is important to check the **educational systems** of the partners/Countries involved*
   b. *It is important to check the **accreditation system** of the (joint) programme in the partners/Countries involved.*
   c. *It is important to check the **legal situation** of the partner involved in relation to the awarding of joint diploma.*
   d. *It is important to check the **legal situation** of the partners/Countries concerned in relation to **tuition and other fees and social cohesion**.*

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Comment:
Communication between partners is vital from the planification stage all throughout the lifetime of the joint program. Evidently, partnerships should be started wherever synergies between partners are identified, but it should be kept in mind that the strategies, personnel and programs are seldom static and are rather changing on a regular basis. Consequently, features, profiles and strengths may change from the original version of the program, particularly if it lasts several years. In the case of EMC with over 20 years history for example, all faculty members originally involved have retired, Helsinki University of Technology was transformed to Aalto University, EIT RawMaterials Academy was established, etc. As a consequence, in order to maintain the trust of the partners, the program structure and organization has adapted to new circumstances. This can only be achieved with ***institutions that have the understanding, flexibility and will to accommodate changes from other partners****, of course always keeping the target of delivering a program that is relevant to the current societal needs.*

4. European cooperation should be guided by curiosity and trust in what is different. Common academic values do not imply a strict uniformity or mainstreaming of content or action. On the contrary, the **culture of jointness builds on trust in and respect of different historical, cultural, geographical backgrounds and perspectives**. The great challenge will be to maintain and enrich this wealth of cultural heritage and diversity in a coherently structured program. [1]

Best practices [2]:

1. *To* ***set up a clear information system on the JPs*** *including clear explanations about their organisation and the different mobility options (practical guidelines about the different possible tracks).*
2. *To* ***provide individual counselling to students*** *to choose their track since the choice of the host university is not (only) linked to the attraction of the city/region/country but has to be linked to the study programme offered there.*
3. *Organisation of* ***extra–curricular activities*** *to foster social and cultural integration.*
4. *Creation of synergies between the Joint Programmes at the institution in order to instil a "****community spirit****" among students and academics.*
5. *Integration of the JP students in the activities organised for the exchange students.*

Comment:
Once more, the best way to describe this point is to identify the reasons why a joint program is attractive. Although agreements should be reached within partners, the autonomy of the partner institutions should be maintained, including teaching philosophy, internal goals and educational

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strategy. The experience of learning in different multicultural settings is widely acknowledged as one of the major strengths and attractiveness of international programs and thus, it should be preserved.

5. In order to ensure that difference becomes a strength and positive value of the program, all partners should **base their cooperation on the principles of transparency and honesty**. Only if these principles are respected, will the joint degree program as a whole be stable and effective. It is the shared responsibility of all partners in the network to analyse strengths and weaknesses in order to identify necessary fields for change and improvement. [1]

Best practices:
See Point 4

Comment:
This is certainly a point of uttermost importance, since all partnerships are driven by trust. In many cases, mistrust it is rather a result of neglect or lack of communication and thus it is advisable to ***have regular meetings with partners to constantly review the viability of the program****. It is also strongly advised to have more than one representative form each partner university to support the flow of information and decision-making, as depending on a single member may result problematic if this person is facing difficulties beyond the scope of the program.*

6. Trustworthy communication between all partners responsible for the joint degree program has an impact on the attitude of each individual partner institution in the network. Each partner university needs to **analyse its own situation regularly** in order to identify what might be relevant for the program as a whole. This self-scrutiny on behalf of an inter-institutional activity is combined with a permanent dialogue with partners sharing the same aim. Joint seminars, conference and regular meetings will also support the sense of jointness, and help each participating institution to contribute effectively to the overall program. [1]

Best practices [2]:
1. *Roles and the tasks of each actor involved (coordinator, institution, faculty, administrative units involved etc.) should be defined during this phase.*
2. *Work jointly and create synergies between different offices (International Relations Office, student affairs, financial, faculty) and involve them from the start of the project.*

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3. *Organising meetings at technical and political levels, involving different services (students affairs office, International Relations Office, external service for accommodation) to guarantee political support and implement the correct procedure.*

Comment:
To have an efficient management of the program, FEMP board meets in a bi-annual basis in person, beside the regular communication for everyday matters. One of the events where FEMP Board meetings are schedule is the annual meeting of Alumni form the program. This is a tradition that has remained popular with students and alumni and fosters the sense of community within the consortium partners.

7. A joint program will only be successful if all parties involved in its realization are **committed to shared aims and objectives** and are able to develop a sense of common ownership. Partners need to define and agree a number of issues that may in one cultural context seem self-evident – for example, what they regard as success and failure. [1]

Comment:
Power balance between partner members is fundamental for the success of a program and is a difficult balancing act too. As a program needs to have a coordinating institution, it is natural to consider that partner as the manager and decision maker, but this should not be the case. In the ***program agreement and in the decision-making regulations****, equal rights and responsibilities should be emphasized, to give an equal voice to each partner and keep a friendly and fruitful cooperation. Only by having these conditions clearly set, will partners also voice their concerns and suggestions in a freely manner.*

8. Striving for a culture of jointness as a distinct feature of inter-institutional quality culture, all parties involved should be **guided by shared academic values**, which may be expressed as a set of agreed quality principles. A necessary precondition is the **will to work together in an international context**. This guiding principle of internationalization may be supported at the university level by an institutional mission statement. [1]

Best practices [2]:
1. *Ensuring the* ***institutional commitment*** *from all partners is crucial. Only with a strong institutional commitment is it possible to bring problems to the decision-making tables.*
2. *Institutional commitment is necessary for obtaining the necessary* ***institutional support in terms of human resources, direct funding, scholarships or services*** *to international*

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*students. It is indeed very important that each partner be committed to invest means (either money or infrastructure/ personnel) and that **not only "people" are involved, but rather the Institutions as a whole**.*

3. *Institutional commitment is also required if the joint programme requires **adaptations of institutional regulations or special derogations** to allow the consortium rules to prevail over institutional ones.*

Comment:
*As the joint programmes are not independent programs, but are part of larger institutional organizations, it is **necessary to corroborate that the universities support this kind of initiatives**. Otherwise, the program will not receive the necessary support at the national or institutional level to be carried out in a practical and successful manner. As a practical example, although industrial visits and excursions to industrial sites throughout Finland and participation in conferences in Aachen have so far been sponsored by FEMP, senior officials have agreed to sustain these activities in case where no such financial support were available.*

9. The organization of a **networked type of cooperation needs to be maintained** at the same time as program activities are sustained in each participating university. All aspects of this specific inter-institutional quality culture will benefit from a broad involvement and participation of all stakeholder groups, notably students, academic and administrative staff as well as senior leadership of the institutions. [1]

Best practices [2]:

1. ***Stakeholders at national and local level** need to be involved in order to advocate the necessary changes in the national procedures and to adapt regulations to innovation (e.g. modification of national regulation on the issuing of joint diploma).*
2. *Stakeholders are also important as a support to institutions in the process of **raising awareness among students and in the labour market** on the existence and value of a joint diploma.*

Comment:
The EMC program through FEMP has designated groups to foster participation from various stakeholders. At the student-level, each cohort appoints a student representative group serving as a link between the participants from the program and the administrative and teaching staff. The student representatives also organize a thorough feedback report in which they evaluate their experience in the program throughout their studies. In second place, FEMP counts with an Alumni Council where former students of the program maintain links with industry via newsletters and the

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yearly alumni reunion. Although not in an official capacity, members of industry are invited to FEMP meetings with the aim of maintaining in perspective the aspects relevant for the industry. Lastly, faculty members involved in EMC are in charge of promoting the achievements of the program within their institutions in order to maintain the support of management and senior officials. This support is much needed to organize, various practical aspects, from streamlined admissions and graduation procedures for a joint degree to arrangements for accommodation and integration of students in the university's student community.

10. Last but not least, in successful joint programs the whole should be more than the sum of its parts. Assuring the quality of "the whole" is therefore necessarily different from assuring the quality of all parts by themselves. **Quality assurance** should therefore be regarded as a shared and integrated responsibility **of the network** as well as a responsibility to be taken by **each participating institution**. In order to embrace all crucial elements and features of the joint degree program which arise "among" the participating institutions, all quality relevant criteria should be linked and considered in relation to the joint degree program itself. A mere "adding-up" of the individual quality assurance activities taking place will not suffice. Likewise, activity only at the program level will also be insufficient since the joint program is not an isolated self-sustaining activity but depends on the individual contributions of each institution in the network. [1]

Best practices [2]:

1. *The adoption of ENQA standards is recommended; for JP development and management, refer in particular to their Part 1: "European standards and guidelines for internal quality assurance within higher education institutions", and Part 1.2 "Approval, monitoring and periodic review of programmes and awards".*
2. *Having a periodic evaluation and follow-up systems (like a quality assurance committee, a joint board, students' evaluation and assessment).*
3. *An effective, updated and comprehensive evaluation systems is a crucial tool for the success of a joint programme.*
4. *The system should include regular evaluation of the academic activities as well as of services.*
5. *Evaluation should be made by different stakeholders, including the students and the academic staff, as well as labour market which is essential for the adjustment of the curricula.*
6. *Guarantee the flexibility of the curriculum, allowing adjustments according to students' and labour market' needs.*

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7. *Guarantee quality in the selection process and in services, in particular in the very important issue of tutoring and coaching.*
8. *Development of an online tool for the whole management of the JP, including students' careers.*

Comment:
As mentioned earlier, the existence of a joint program is only justified when cooperation brings the best qualities of each institution. The message of this final point is to find a system capable of assessing the quality and sustainability of the joint program. This is a difficult exercise since each university has its own regulations for quality assurance and it may be difficult to implement such system specifically for a single program. In the case of Aalto University, EMC is internally treated equally as any other Master's program and is consequently evaluated following the university's own procedures. In addition, the involvement of organizations such as EIT may be useful. During the process to obtain the EIT Label, the EMC consortium was forced to evaluate the program according to quality parameters defined by EIT. This evaluation process is continuous and forces the consortium to evaluate the program's quality from a third party's perspective.

2.2. References

[1] S. Hofmann, D. Crosier, "Institutional guidelines for quality enhancement of joint programs" in EUA Bologna Handbook. C4.5-1 (2006)
[2] JOIMAN Network, "How to manage joint study programmes – Guidelines and Good Practices from the JOIMAN Network" (2010)
http://ecahe.eu/w/index.php/How_to_Manage_Joint_Study_Programmes#Source

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3. Chapter 3: Organization and management issues

3.1. Introduction

What is a Mobility Window and why is it important?

This chapter provides guidelines for strengthening student mobility through effective mobility management, structured support for mobility students, inclusive mobility windows, outlined internationalisation strategies and promotion activities.

The European higher education policy fosters the internationalisation of higher-educational institutions. The idea of study programmes with structurally integrated mobility was implemented already in the 1960s. Over the last few years, European policies have set the increase of mobility volumes as a central priority and the idea of student exchange and internationalisation of higher educational institutions has been re-discovered in the context of **Mobility Windows (MW)**. A mobility window is a period of time reserved for international student mobility that is **embedded into the curriculum** of a study programme, according to a definition given by the *Academic Cooperation Association (ACA)* in the *ACA Papers on International Cooperation in Education* [1]. It can be embedded as mandatory or optional within a study programme and should underlie a certain degree of curricular standardisation. The mobility programme should offer a comparable level and field of education at another higher educational institution beyond borders.

Study abroad programmes can imply diverse institutional practices. The term of mobility windows became part of Europe's national discourse already in the mid-2000s. Up until then the concept of mobility windows has been mentioned only rarely in the context of higher and international education beyond European borders. In the beginning, MW were related to the development of study programmes and degrees throughout the Bologna Process.

The German Academic Exchange Service (DAAD) and experts from the Conference of the Swiss University Rectors (CRUS) in Switzerland were amongst the first to refer to the concept of MW in 2005, respectively 2004, followed by Jan Figel, a former EU Commissioner for education, training, culture and youth, who mentioned the term in an interview back in 2008. He interpreted MW as

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"[…] remedy [...] for the overloaded study programmes", which were developed under Bologna reforms with the aim to foster student mobility and yet did not incentivize an increase of student mobility activities as desired.

Based on qualitative features like programme objectives, students' participation, impact on curriculum, partnerships and management specifics, the League of European Research Universities (LERU) differentiates between three types of mobility:

- Exchange mobility (e.g. ERASMUS),
- Networked mobility and curricula (between partner institutions),
- Embedded mobility and curricula (e.g. Erasmus Mundus).

Stakeholders share a common vision regarding the future development of MW. In 2009, European Education Ministers announced in their Communiqué [2]: "Within each of the three cycles, opportunities for mobility shall be created in the structure of degree programmes. Joint degrees and programmes as well as mobility windows shall become more common practice."

Study abroad programmes have been integrated into undergraduate study programmes across European educational institutions since the mid-1970s and had to be organized individually. Later on credit recognition and the exchange between educational institutions have been recognized as important and thus organized study abroad programmes became integrated in the curriculum as "arrangement negotiated between higher education institutions (or individual faculties/departments) in different countries, whereby students are given the opportunity of spending a significant part of their higher education studies in another country" (Burn et al., 1990, p.11) [3].

Austrian universities have concluded performance agreements with the Federal Government on orientating and objectivizing their strategies towards European and international developments and benchmarks. Their internationalisation and mobility strategies comprise the following main points, among others:

- ensuring a MW in the curricula,
- transparent recognition practices,
- measures to facilitate quality in mobility,
- increase in numbers of outgoing and incoming students and teachers.

One of the objectives of Austrian higher educational institutions is to ensure that at least 30-35% of graduates have completed a period abroad relevant to their studies by 2025. The European goal was set at 20% and has been already achieved in Austria. In order to support and promote the mobility of students, Austria offers a wide range of international educational activities, like supportive funding options within Erasmus+ for bilateral and multilateral cooperation projects

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and special doctoral fellowships. Each year more than 6,000 Austrian students and around 1,300 teachers and other higher education establishment members use the offers of Erasmus+, according to statistical data provided by the European Commission.

Internationalization at TU Wien underlies strategic principles that aim to increase the quality of research and teaching and integrate the necessary service facilities as pinpointed in the TU Wien International Global Strategy 2013+ [4]:

- TU Wien orientates its international exchanges with excellent universities according to strategic considerations.
- TU Wien strengthens its opportunities for systematically recruiting qualified students, junior scientists and professors from abroad by creating an attractive, intercultural research and study environment.
- TU Wien promotes the international mobility of its students, junior scientists and professors.
- TU Wien strives to improve its international visibility and marketing.

TU Wien engages rectorate and faculty staff members to set and measure objectives in regard to the enumerated point above.

What are the benefits for students, institution, teachers?

Studying and living abroad is one of the key elements in the internationalisation of universities, and for students to gain valuable intercultural, personal and social skills. Mobility windows provide a unique opportunity for every candidate to gain invaluable new experience, to learn foreign languages and to develop interpersonal skills in a new and culturally diverse environment. Increased number of young professionals who can make a positive impact on their local environment is a desired outcome. Experience shows that student mobility can be substantially increased by adequate promotion and supporting activities.

Educational institutions and teachers benefit from offering mobility windows by developing and maintaining joint activities in research and teaching, enhancing international partnerships, collaborative practices and academic exchange as well as strengthening the international character of their subject courses and improving the international visibility of their educational institution.
Benefits for students concern improvement of education possibilities and new opportunities for gaining international experience and encouraging international students exchange next to proven enhancement of students' employability.

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3.2. Mobility management

Multi-stakeholder partnerships and sustainable cooperative approaches between partners are important premises for establishing successful mobility windows. Crucial in successful mobility management is to have a ***Rulebook on student mobility*** [5], [6], and ***recognition of ECTS*** adopted at the university level.

How to ensure an efficient mobility management?

The following structure should serve as a recommendation on dividing responsibilities and tasks and acquiring partners important for the successful implementation of mobility windows.

- *Central Administration, Service Units:*

The International Office (IO) is the central project management body of mobility programmes. It provides program information for university staff, incoming and outgoing students and is responsible for international contracting and compiling statistics to track and screen mobility activities in a tangible manner. It serves as a student counselling for "outgoing"-students and hand in point for scholarship programmes. It services incoming students by providing information about the host university, registration process, visa, housing, search for supervisors, etc. The IO is also responsible for the financial management of the university budget for international relations and offers support for the implementation of the internationalization strategy of the educational institution it is embedded in.

The EU-Research Support Unit provides information about EU research programmes and advices for project-management applications, contracting, IPR, audits, etc.

The Office for Studies and Examinations is responsible for the admission of (foreign) students and the issuing of study-related certificates.

- *Student organisations:*

They are responsible for facilitating international activities like social programmes for incoming mobility students (Buddynetwork) and creating offers for international internships and summer-schools (IAESTE, BEST, etc.). They also assist the International Office in programme management and mobility promotion.

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- *External Partners:*

National scholarship provider/national agency for international programmes provides information for Austrian universities about international education and scholarships and is responsible for PR-activities for Austrian universities, like international study fairs.

Good practices

MOBILITY WINDOW PROGRAMMES AT:

AALTO UNIVERSITY

- Erasmus,
- Erasmus Global mobility,
- Nordtek,
- FIRST,
- Magalhaes,
- Cluster,
- Bilateral agreements.

UNIVERSITY OF ZAGREB

- Erasmus+
- Bilateral Agreements
- CEEPUS.

National Research Funding Organisations

Good practices

AALTO UNIVERSITY

Aalto University provides each outgoing student with exchange scholarship. In addition, students may apply for other scholarships. Finnish nationals often receive student benefits from the government. These benefits are granted also for the time of mobility.

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UNIVERSITY OF ZAGREB
List of the official bodies serving as national scholarship providers on international student activities in Croatia:
- AMPEU https://www.mobilnost.hr/en/
- Ministry of Education https://mzo.gov.hr/en

EU

The EU provides Erasmus+ to support educational and training activities in Europe to over 4 Million Europeans; the European Institute of Innovation and Technology (EIT) provides mobility programmes and exchange opportunities for students, researchers and entrepreneurs with the aim to increase Europe's competitiveness, its sustainable economic growth and job creation by promoting and strengthening cooperation among leading business, education and research organisations and to power innovation and entrepreneurship in Europe by creating environments for creative and innovative thoughts to thrive.

Good practices (example TU WIEN)

QUICK OVERVIEW OF PERSON IN CHARGE AND PARTNERS

Rectorate:	*Vice-Rector for Academic Affairs*
Departments:	*Program Coordinators*
Faculties:	*Dean of Study, Delegates of International Affairs*
Admission Office	
OeAD:	*National agency programme offices*
Student organisations:	*Buddy Network, BEST*
EU Research Support	

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How to structure an International Office?

Based on the experience, the best practice in organising internal structures to improve the mobility of students is to have:

- **Mobility coordinator (Local International Relations Officer)** at each faculty and/or department (should be an administrative and not academic person).

  Responsibilities: bilateral agreements at faculty (or department level), exchange students, checking which universities and programmes are eligible for students of their faculty, i.e. departmental, to keep records of exchange students, and credits that have been taken abroad and recognised, to keep in touch with the exchange students while they are abroad, taking charge of receiving the transcript of records after mobility, and help students with the recognition process.

- **Institutional coordinator** or **rector's delegate** for mobility and academic coordinators for each faculty to manage and sign all relevant documents related to student mobility

  Responsibilities: They must have authority to sign mobility partnerships, learning agreements and the recognition of grades. Recognition regulation should be prepared at central, institutional level and made available (online) to all incoming and outgoing students.

- **Study dean** from each faculty responsible for the compliance of subject courses between partner universities and for the recognition of studies

  Responsibilities: They must have the authority to propose the adoption of new courses or adapt existing ones, so that a compliant study programme can be made available for exchange students between the partner universities

- **Data manager** of mobility (database, mobility software, records of both outgoing and incoming mobility), website

  Responsibilities: They must maintain the website and database of the International Office and keep track of records of both outgoing and incoming mobility students

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Good practices (example AALTO UNIVERSITY)

MOBILITY SOFTWARE
Aalto University uses MoveOn4.
Destination Database available at: https://aalto.moveon4.de/publisher/9/eng#

- **Communication manager** to promote mobility offline and online (e-Mail, Newsletter, Homepage, Info Days ...)

  Responsibilities: They must establish a communication strategy to evaluate the most efficient communications channels for reaching a high number of students. They actively promote the offerings by the International Office and cooperate with student organizations to increase reach and facilitate events. They are responsible for fostering exchange between the exchange students and promoting internationalisation between the target groups.

- **Financial Manager** to manage International Office budget

  Responsibilities: They must keep track of all financial matters related to the activities of the international Office and are responsible for budget-related tasks, reporting and transparency.

Good practices (example TU WIEN)

- *Rectorate:*
  The Rector and the vice-rectors represent the university "diplomacy" and are responsible for making strategic decisions. The Vice Rector for Academic Affairs is responsible for signing international agreements and building the international strategy together with the Rector, the Vice Rectors, the Deans and the International Officers. The Vice Rector for Research is responsible for monitoring international research activities and making strategic decisions.

- *Faculties:*
  The Dean is responsible for building strategy on faculty level. The study dean is responsible for the recognition of studies completed abroad. The Study Commission is responsible for the development of international study programmes and requires an approval by the

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Senate. The International Delegates are responsible for stimulating the communication flow on international topics and for building strategy on faculty level.

- *Departments:*
  The Head of Department is responsible for signing research contracts in the name of the university. Program-Coordinators are responsible for building partnerships, selecting outgoings and serve as academic advisors for incomings.

3.3. The organization of academic recognition

It is crucial that students are secured before their exchange programme starts, that their study period abroad will be **fully recognised** when they get back to their home institutions. Each university thus should have an **official document** that regulates the mobility of students and recognition of the study period that students have spent on other higher education institutions. This document should contain acts, regulations and form.

- **Official document regulating MW and recognition of study period** (should be officially adopted by the Senate of the University and be legally binding) Ensure diverse and flexible curricula with MW of 30 to 60 credits that can be obtained at the host educational institution. **All information regarding student mobility procedures should be made available in English and the national language**.
- The University should see academic mobility as a strategic target and an important element of evaluation
  By increasing the number of English degree and language courses and providing opportunities to obtain internationally recognized certificates in English, the university will encourage students to become interested in international activities and will give an incentive to universities to strive to add the MW concept to their internationalization strategies.
- Careful selection of partner institution, checking the (on long-term) equivalence and compatibility of the programs, courses
  A careful selection of the partner institutions and ensuring the equivalence or the compatibility of the study programmes is a main incentive for students in mobility programmes.
- Transparent description of study periods, Diploma

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Mobility windows can be clearly illustrated by programmes, which have already been segmented into their relevant courses, including an overview of the learning outcomes and the implied assessment methods. A detailed online catalogue of the degree courses in English including all relevant information should be made available on the university's website.

Issuing of the diploma supplement should aid recognition and transparency.

- Unified student application form
  It is recommended to use official European forms.
  There is a unified EU Learning Agreement for ERASMUS+, which is mandatory to be used by the partner institutions
- Recognition of ECTS at the university level
  Mobility students must know in advance what is the amount of ECTS credits that they can get recognized by the national university before the exchange begins.
- Development of a learning agreement, study plan
- Transcript of records (language English/native)
  Track of the credits taken abroad should be kept for each course and information in this regard should be provided to outgoing students. A calculation of the statistical distribution of the grades for each degree course will allow an accurate conversion of the grades.
- Appointment of an Institutional Mobility Coordinator
- All procedures related to student mobility should be published and made available online
- Monitoring of the agreements will assure quality control
  It is recommended to evaluate closely the student experience, the academic provision and the ease of completing administrative tasks. By creating an evaluation system to assess quality, ease of access, functionality of present networks and the usefulness of the available information material for mobility students.
- Organised presentations at faculties should inform all academics about new possibilities and regulations regarding mobility and academic recognition.

EU MODEL CONTRACTS

- *EU Inter-institutional Agreement: https://ec.europa.eu/programmes/erasmus-plus/resources/documents/applicants/inter-institutional-agreement_en*
- *EU Erasmus+ Learning Agreement: https://ec.europa.eu/programmes/erasmus-plus/resources/documents/applicants/learning-agreement_en*
- *EU Erasmus+ Student Charter: https://ec.europa.eu/programmes/erasmus-plus/resources/documents/applicants/student-charter_en*

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- *EU Erasmus+ Charter for higher education: https://ec.europa.eu/programmes/erasmus-plus/resources/documents/applicants/higher-education-charter_en*

Good practices (example TU WIEN)

ACADEMIC RECOGNITION FOR OUTGOINGS

The recognition of academic achievements for outgoing students takes place up to two months after the comeback of the outgoing student to their home country as long as they have submitted their Transcript of Records. Otherwise, the academic recognition may be carried out with delay depending on the submission date of the Transcript of Records.
The academic recognition is done in accordance with the Learning Agreement as stipulated between the outgoing student and the academic dean. If all study courses have been passed with success, then all of them shall be recognized.
The ECTS grading scale (A-F) is taken into account for the conversion of grades.
***EU provides a mandatory Learning Agreement Form**, so this form is also being used at TU WIEN. Therefore, the in-house development of an internal Learning Agreement is redundant.*

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3.4. Outgoing students

General information

- Internal structures, courses and support services
- Scholarship programs supporting MW (Erasmus, National funding, Industrial supported funding, research scholarships of host/sending institutions, …)
- The selection committee (members, evaluation criteria, process, transparency,...)

Internal structures, courses, procedures

- Mobility Coordinator: an administrative person, who is student-oriented and serves as a Local International Relations Officer
- Student Mobility Coordinator: an administrative person to focus on mobility related issues, give support and update information on active mobility programmes, scholarship opportunities, activities and to support applicants
- Mobility software for data collection on mobility

Good practices (example TU WIEN)

IN-HOUSE MOBILITY SOFTWARE

Mobility Service is the name of the internal administrative software system for managing Mobility Windows at TU Wien. It is linked to the university's Information and Service System platform for administration and management of the curriculum at TU Wien (TISS). Direct Access to the Mobility Service is granted only to staff members of TU Wien's International Office, academic deans and all department coordinators at the university's faculties.

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Promotion of MW among students

- **Presentations and info days**
  Could be organised prior to and during the application call, at all faculties within a university. Prepare information leaflets about scholarships for exchange or degree programmes and give them to students at the presentation, while having an info-stand in the faculty lobby, or even while visiting students at the beginning of lectures. Inviting student ambassadors (former scholarship holders) as guests for providing first-hand information, sharing their experiences on the application process, their time spent abroad, and for all detailed questions.
- **Scholarship Fairs**
  Annually organised by the University (usually October). Present all active mobility programmes, from short exchanges, exchange scholarships and Masters and PhD studies, to student internships abroad, summer schools, and language courses.
- **University/Faculty homepage**
  All relevant data of MW: mobility process, application requirements, necessary documents and experiences from former scholars, course type, university, city, duration, starting time, enrolment deadline, ECTS, language, contact persons, FAQs
- **Interactive promotion**
  Facilitate roundtables, discussion, panels, debate to advise and motivate students and teachers to get involved in internationalisation, learn about mobility-related opportunities and challenges and prepare for an exchange. Invite teachers to interact with students and involve the IO staff to ensure a wide coverage of topics and needs and enable answering detailed questions on spot as well as sharing experience first-hand. Create a Book of Memories with stories of exchange students.
- **Other promotion channels for internet and electronic communication** (to reach specific target groups, activities, audience)
  Present all active IO offerings via Newsletter, social media (Facebook and Twitter), website, downloads, FAQ and make the mobility process as transparent as possible
- **Establishing cooperation** with different units of the university, such as the Career Service, Student Parliament and student organisations.
  They can more easily access students and can provide access to their own facilities and events. Cooperate with local media to ensure a wide reach (TV network, newspaper, magazines)

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- **Individual consultations**
  Arranging days or parts of a working day as “open doors” for students interested in mobility options. Possible also in group consultations (when a group of students applies for the same programme).

Supporting students in the application procedures

It is a significantly important step that supports the whole mobility process. Students feel much more secure and often lack the proficiency and experience in preparing solid application documents.

Most students encounter the same problem - not having one of the internationally recognised language certificates that are mandatory for most mobility programmes. This requires planning and preparation. Remind your students at the end of the academic year before summer break to plan for mobility, to improve their language skills and take exams for official language certificates. Explaining the overall process of mobility to the students, about their obligations, but also rights.

Address the most important and crucial aspects:

- CV (good quality, different types – EUROPASS format if an EU)
- motivation letter (concise and explanatory), personal statement, essays (answering several questions)
- Application form

A good way to address these issues either individually or collectively:

- Organisation of workshops: development of CVs, motivational letters, essays, interview training, and other general parts of the application (deadlines, obligations, rights, costs, selection criteria, etc.). Several of these sessions during the application period, possibly limiting the number of attendees to make it as efficient as possible.
- English skills improvement, language certificate (preparatory language courses using TOEFL and IELTS literature)
- Individual consultations
- Involvement of student ambassadors (former grantees of scholarships) to support the students in their application procedure
- Communication via e-mail, website and social networks,
- Offering tailor-made support and concrete assistance during the application process.

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3.5. Incoming students

One of the EU's goals is that at least 20% of the student population should spend some period of their studies on mobility abroad. Lack of funds is the greatest obstacle for not participating in a mobility programme.

Internal structures, courses and support services

- A person in charge of incoming students
  Could be also the mobility coordinator for the university
- Introducing courses taught in the English language
  Students coming from abroad are mostly interested in topics taught in English. Undergraduate studies are usually in the native language but in Master and Doctoral studies, English courses should be widely available if you want to attract foreign students.
- Courses in the national language
  Students staying for more than one month want to learn the language and culture of the country
- Make sure the offer meets university requirements such as study programmes available in English, mentor's availability, provision of research tools and others.

Promotion to increase the number of incoming students

The key factors in choosing the university are programmes given in English, the international reputation of the university and the level to which programmes are tuned to the student's home studies. To attract students from abroad, it is important that the offer from the university meets requirements, such as study programmes in English, lectures, providing mentors, and the provision of research tools and other forms of educational activities. Most important is to have all the information available in English. The translation can be either outsourced or be done internally by advertising a volunteering translation job to students or offering a summer internship.

- Website
- Social media pages
- e-Newsletter
- Posters, flyers, folders
- study Programmes catalogues

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- Testimonials - A personal story from the student who participated in the mobility experience
- guide for Incoming Students – a concise guide in English
- Promotion through Buddy Network/ Erasmus Student Network

Educational courses:

- Summer and Winter International Schools - for promotion of the University
- National language courses

Welcoming activities and integration

A crucial part of the adaptation of foreign students to the host university and its environment is to provide good communications and offer prompt responses to foreign students before, during and after their mobility periods.

- responsible host contact person (contact before arrival, visa, health insurance, travel, accommodation ...)
- after the arrival: documents, organisational topics, language course,
- Welcome Day/Week
  Information about their rights and responsibilities related to their studies and their stay. Organisation a range of activities (respective culture and customs through intercultural dinners, films, music and similar intercultural activities).
- Buddy network/fellow students (important for the integration process, provide helpful assistance during the arrival of foreign students, finding accommodation, accessing university facilities and services, administration requirements, life in the town, reducing potential cultural shock and social isolation. etc.)

Good practices (example TU WIEN)

General Support:
The International Office provides several orientation and support programs, including:

- *Welcome letter and welcome guide;*
- *Orientation session before the semester starts, where detailed information and tips about studying at Vienna UT are provided;*
- *SoS-Orientation Programme http://www.ai.tuwien.ac.at/international/ .*

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Financial Support:
There is a scholarship database of the OeAD: http://www.oead.ac.at .
The Kurt Gödel Society can provide financial support to students for special activities, courses, attending summer schools, etc. http://kgs.logic.at .

Accommodation:
The students can apply for different student accommodation alternatives via the OeAD Housing Office http://www.housing.oead.ac.at/index_e.asp .The welcome letter that is sent to all incoming students by the International Office contains instructions for sending the housing application, as well as links and tips to other possible accommodation alternatives.

3.6. Alumni – MW Ambassadors

Involving former MW holders to MW events and promotion activities will enable perspective mobility students to learn from diverse first-hand experiences and ask detailed questions on the spot as well as to gain peer support on their applications. By organizing a get-together for students, they can exchange information on future professional and personal perspectives in regard to MW. It is recommended to keep track on exchange students' experiences by creating a Book of Memories or initiating reporting, so that fellow students can benefit from the experience of previous mobility students.

3.7. Inclusion and diversity

Gender Aspect

All forms, documents and information materials should be written preferably with gender-neutral noun and pronouns (e.g. instead of “chairman” - “chair”). According to the EU Interinstitutional Style Guide [7], gender-neutral drafting means:

- avoiding nouns that appear to assume that a man rather than a woman will perform a particular role: ‘chairman’ is the most obvious example;
- avoiding gender-specific pronouns for people who may be either male or female.

It is pointed out that if the text clearly refers to a specific individual on a particular occasion and the gender of the person concerned is known, a gender-specific pronoun should be used.

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Alternatives in regard to the circumstances may be considered as follows:

- Rendering general concepts in English is very common, thus drafting in plural, where possible, is recommended;
- Omitting the usage of pronouns altogether is recommended (e.g. “The chair expressed ~~his/her/its~~ dissent.” ; “The spokesperson voiced ~~his/her~~ opposition to the amendment.”;
- Substitution of “the” and “that” for the possessive pronoun (e.g. “A member of the Court of Auditors may be deprived of ~~his~~ the right to a pension.”);
- Usage of third person plural pronouns (they/them/their/theirs) to refer back to singular nouns (“Identify the **person** responsible and take **their** advice.”)
  This form should be used only when the reference is absolutely clear. It used to be perceived as grammatically incorrect, but currently it is a widely used form.;
- Usage of “he or she” is preferred instead of “he/she”, “(s)he” or “s/he”, which are recommended to be avoided;
- Repetitive usage of the noun instead of a pronoun may be a useful technique to imply gender-neutrality in longer sentences.

Beyond disabilities - European Mobility for all

Inclusion and diversity are part of Europe’s 2020 Strategy that aims to generate smart, sustainable and inclusive growth in the EU. According to the Practical Guide for European mobility activities on involving young people with disabilities [8] “...the EU strives to encourage the social inclusion of people with disadvantaged backgrounds and to promote diversity in Europe, while making sure that every individual has the possibility to take part in building European values.”
Following main objectives have been adopted by the Erasmus+ Inclusion and Diversity Strategy:

- Creating a common understanding of those who may be considered as young people with fewer opportunities and a coherent framework of support
- Actively reaching out to disadvantaged groups, when promoting Erasmus+ mobility programmes
- Reducing obstacles for young people with fewer opportunities to participate in mobility programmes and help applicants to overcome obstacles
- Support organisers in developing quality projects that involve or benefit young people with fewer opportunities
- A cross-sectoral approach for establishing links between initiatives that benefit young people with fewer opportunities
- Investing in the intercultural and social skills of young people and youth workers as well as their competences to manage and work with diversity in all its forms

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- Increasing the recognition of the experience and skills gained by young people with fewer opportunities in Erasmus+ and by the youth workers working with them
- Ensuring that the focus on inclusion and diversity is present in all stages of Erasmus+.

3.8. References

[1] ACA Papers on International Cooperation in Education "Mobility Windows From Concept to Practise" (2013)
[2] Leuven/Louvain-la-Neuve Communiqué (2009)
[3] Burn, B. B., Cerych, L. & Smith, A. (eds.) (1990). Study abroad programmes, Higher Education Policy, 1 (11). London: Jessica Kingsley Publishers.
[4] TU Wien International Global Strategy 2013+ https://issuu.com/tuwien/docs/tu_international_global_strategy
[5] University of Banja Luka "Rulebook on student and staff international mobility"(2017)
[6] Singidunum University RULEBOOK ON STUDENT MOBILITY AND RECOGNITION OF ECTS CREDITS (2014)
[7] European Union EU Interinstitutional Style Guide (2011)
[8] BEYOND DISABILITIES - EUROPEAN MOBILITY FOR ALL! - A practical guide for organisations interested in European mobility activities involving young people with disabilities

3.9. Useful Links

- European Commission Erasmus+ Programme Guide Overview
- European Commission The Student Charter highlights the rights and obligations of students participating in Erasmus+ (by country)
- Aalto University Selection Criteria and Terms of Exchange at Aalto University
- Aalto University Summary of key activities at Aalto University

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4. Chapter 4: Industry trends and policy perceptions in the ESEE region concerning the raw materials sector

4.1. Executive summary

This report contributes to a guideline material for the networking universities and industrial partners with an analysis on the industry trends and policy perceptions in the ESEE region concerning the raw materials sector. It will help and guide the networking universities and the mentoring partners to select and develop the most industry-relevant mobility pathways in the future MOBI-US network. Main emphasis is given to mining, minerals and recycling related issues and to materials engineering ones.

This task takes its roots in the MIN-GUIDE project, where related topics are analysed (read the full reports at www.min-guide.eu). Brief analysis of the deliverables from this project, relevant to MOBI-US network development is done, and conclusions for MOBI-US implementation are drawn, which will lead to the chapter to be included in D1.6.

Innovations of different types were recognized and described as driving factors in the following fields: (i) Exploration and extraction; (ii) Deep sea mining; (iii) Mineral and metallurgical processing; (iv) Waste management and mine closure; (v) EU minerals data and minerals policy governance; (vi) Circular economy and recycling.

For MOBI-US network development and creating mobility pathways within, it is suggested to consider and use the following topics and trends, previously studied in MIN-GUIDE: (i) Value chain specific context and challenges; (ii) Innovation types and characteristics, (iii) Recommendations on future policy.

Alongside the analysis and identification of items from MIN-GUIDE, this report contains a set of recommendations and conclusions (entitled in all subchapters as *Impact on MOBI-US network development*) for the proper knowledge transfer from MIN-GUIDE and the implementation of important items in the MOBI-US project activities.

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4.2. Introduction

The key objectives of the MIN-GUIDE project (www.min-guide.eu), on which this *Opportunity analysis* chapter for MOBI-US *Structured Mobility Guideline* rely on, are: *(i) to provide guidance for EU and EU Member States' (MS) minerals policy; (ii) to facilitate minerals policy decision making through knowledge co-production for the transferability of best practice minerals policy;* and *(iii) to foster community and network building for the co-management of an innovation catalysing minerals policy framework.*

The **innovation-driving factors** are recognized as crucial for the future policy development in mineral and metallurgical processing. These should be also considered as important for networking MOBI-US academic partners, in order to develop courses and programmes related to industrial partner needs and innovative directions. Results of the analysis on **innovation-driving factors along the whole mining value chain** (i.e. permitting, exploration, extraction, deep sea mining, cross-border exploitation, processing, waste management, recycling, remediation, and mine closure) with **important recommendations on policy governance** and **recommended standardisation and systematic reporting requirements for EU minerals data** are reported in MIN-GUIDE D1.3 and D4.3 (www.min-guide.eu).

The secure and sustainable supply of raw materials is a pressing issue in the European Union due to Europe's strong import dependency. Relevant minerals policy frameworks for the 28 EU Member States and the EU were compiled, focusing on individual minerals and related policies and legislation and minerals policy governance frameworks as well.

Three **core perspectives** important for the innovation framework were recognized: *(i) minerals and mining industry, (ii) public policy and governments,* and *(iii) external*. The innovation framework identifies different innovation categories that are of different relevance depending on the perspective in the raw materials sector, i.e. the innovation categories depend on the perspective of the innovator.

Main perspectives and legislation for ESEE countries of the networking universities (Poland, Hungary and Croatia) are listed at the end of this report (see Chapter 3.2.5 in this report) and it should be considered while creating different mobility pathways among networking universities.

The innovation framework differentiates between 5 different **types of innovations**: **(*i) product, (ii) process (also includes input innovation), (iii) marketing, (iv) organisational*, and *(v) system innovations***. A key point to consider is that the innovation type may differ according to an organisation's role in the value chain (i.e. one actor's product innovation may be another's process innovation). For example, a technology supplier's product innovation is, from a mineral processing form's perspective, a process innovation.

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Product and process innovations, among all above mentioned types of innovations, should be primarily considered while developing courses, programmes and mobility pathways in the future MOBI-US network. However, marketing, organisational and system innovations play important roles in the whole picture development and should be also seriously taken in account.

4.3. The MIN-GUIDE project outcomes and their impacts on MOBI-US network development

Innovative processing

The report MIN-GUIDE D4.3 elaborated how innovations in mineral and metallurgical processing are generated or taken up in different EU Member States and on EU-level and how this is either facilitated or inhibited by policies and legislation on national or European level. Recommendations for future development of mineral and metallurgical processing sector were evaluated. Conclusions and recommendations for future policy development for innovation in mineral and metallurgical processing were developed and main findings are the following:

- most of the mineral policies are addressing the entire mineral value chain;
- several statutory provisions are related to mineral and metallurgical processing;
- national mineral policies are not very much addressing the mineral and metallurgical processing, while recycling is dislocated from mining/mineral legislation.

Numerous strategic policy initiatives (e.g. *the Strategic Implementation Plan for Raw materials, the revised EU Industrial Policy Strategy, the Raw Materials Initiative*) improved perception on the EU level of the policy makers towards the raw materials industry. The use of raw materials from secondary sources has been identified as being an integral part of the life cycle of materials. However, innovations in mineral and metallurgical processing are not supported at strategic and economic/investment level. The policy is neutral or inhibiting through long and uncertain permitting procedure or is indifferent to innovation as to mineral and metallurgical processing. Consequently, the European knowledge and skills base in mineral and metallurgical processing has diminished during the past 20 years. Networking projects, such as development of MOBI-US network of structured mobilities between networking universities in ESEE region have, therefore, a **promising opportunity** to improve these gaps!

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Cornerstones of an innovation policy framework

To address the challenges of secure and sustainable minerals production, the European Innovation Partnership's Strategic Implementation Plan (EIP SIP) defines **cross value chain innovation** and **boosting of innovation capacity** as key success factors. A modern **minerals innovation policy framework** is an important cornerstone that can facilitate such innovation.

Exploration and extraction

Exploration is the first step in the mining value chain which includes all processes related to finding ores (commercially viable concentrations of minerals) for the purpose of extraction at a later stage. Extraction involves the development, the opening of an ore deposit for production, and exploitation, the large-scale production of ore in a mine.

Value chain specific context and challenges

The key innovation drivers and/ or challenges and outcomes in exploration and extraction, mainly in the European Union context were identified. Commodity prices are the most important challenge for expenditure on exploration itself. This is indirectly important for innovation because if overall exploration expenditure is low, so is expenditure (and the need) for innovation. Geological potential and data, with its theoretical and technical aspects, is considered the most relevant direct challenge for innovation. Data availability may be an important exploration challenge and innovative ways of data access are essential. Also, suitable mining policy, i.e. policy that enables mining per se, is an important driver with scope for innovation. For extraction, costs and productivity, orebody geology (incl. remote, lower grade or more complicated orebodies), legislation (e.g. environmental) and the health and safety of employees are considered key challenges for innovation in the sense that they either require companies to innovate in order to stay competitive or to fulfil changing societal expectations.

Innovation types and characteristics

The vast majority of the exploration innovations are **process innovations**. Only one, the "overarching mining code" (meaning an integrated, modern one-stop-shop concerning the whole mining value chain), can be considered a **system innovation** and some of the process innovations also include elements of organisational and systematic changes. Similarly, the vast majority of the extraction innovations are **process innovations**, with some of them including some organisational elements. "Land use planning governance" and "new business models" can be considered **system innovations** and "better skills base" an **organisational innovation**.

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Innovation in mineral exploration develops intensively in application of robotics, portable analytical instruments (XRF, LIBS), drone-mounted geophysical and image acquisition equipment. Relevant achievements from EU-funded projects shall be mentioned such as

- UNEXMIN (https://www.unexmin.eu/), which has developed underwater robots for exploration of flooded abandoned mines.
- ROBUST (http://eu-robust.eu/), aiming sea bed 3D mapping and in situ material identification by means of a LIBS equipment mounted on an AUV (autonomous underwater vehicle).
- SOLSA (https://www.solsa-mining.eu/), a project which develops an automated expert system for on-site core analysis
- Smart Exploration (https://smartexploration.eu/), focusing on application of new ways of geophysical exploration by seismic, electromagnetic and potential-field methods.

Concerning mineral extraction, the application of artificial intelligence, robotics, low-impact mining technologies are important trends for innovation. Relevant examples can be mentioned from EU-funded projects as

- ROBOMINERS (https://robominers.eu/) which aims to construct a fully functional modular robot miner prototype following a bio-inspired design. The robot will be capable of navigating and performing selective mining in a flooded underground environment,
- SLIM (https://www.slim-project.eu/) focusing on solutions for exploitation of small mineral deposit which provide cost-effective and sustainable selective low impact mining, applying innovative blasting models and mitigating dust formation, vibration effects and nitrate leaching migration.
- SIMS (https://www.simsmining.eu/) which has developed sustainable intelligent mining systems such as application of virtual reality and augmented reality applications, high-end communication networks and automation solutions, robotization.

Recommendations on future policy

Raw materials related EU and national policies and strategies, and other policy areas:

- *develop a strategy for the management of solid non-energetic raw materials in every EU MS*
- *provide accessibility and safe supply of raw materials*
- *foster and simplify permitting procedures for exploration and extraction of raw materials*

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- *follow and shape policies in other areas*

Societal issues such as health and safety or the environment and education:

- *improve the social acceptance and the public perception of mining*
- *RDI policies and tax incentives*
- *research activity/financing*
- *resource characterisation*

Impact on MOBI-US network development

For MOBI-US network development it will be crucial to implement different types of innovations within courses and programmes while creating mobility pathways. For the courses and programmes dealing with exploration and extraction of raw materials it is recommended to involve industrial partners suitable for implementation of abovementioned innovation types (mainly process and system, as well as some product innovations) and recommendations in accordance with stated policies, strategies and societal issues.

Deep sea mining

Deep sea mining is still at an early stage of development. Presently, only one successful deep sea ore extraction test was carried out in offshore Japan in September 2017. Offshore mining exploration and extraction technologies and methods already exist but need improvement both in terms of cost-efficiency and environmental impacts minimisation and mitigation. Environmental challenges are significant and not easily quantified. Direct impacts on deep sea ecosystems and the effect of contamination plumes need to be addressed, and specific regulating policies and legislation at national and EU level need to be developed.

Value chain specific context and challenges

Key challenges in deep sea exploration and extraction generally include:

(i). innovative and cost-efficient exploration and extraction methods, capable of detecting and mining ore bodies at considerable ocean depths and below the sea bottom, and that can cope with the extreme conditions of deep sea extraction;

(ii). exploration and extraction technology and methods capable of minimising and mitigating environmental impacts;

(iii). real-time cost-effective technology for efficient monitoring and deep sea habitat mapping prior to, and during, extraction operations;

Additional challenges include, amongst others, the huge lack of knowledge of the deep sea environment and deep sea habitats and ecosystems, the lack of baseline references prior to exploitation, the need to define no-take zones in the vicinity of mining areas to preserve

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representative ecosystems and capture the local and regional heterogeneity/diversity, dealing with equipment corrosion and operation at high pressures, and addressing social concerns.

Innovation types and characteristics

At the present stage of deep sea mining, both **process** and **system innovation** are particularly critical. **Process innovation** is prevalent since this is an emerging new field. **System Innovation**, as concerns the development of innovative legislation and policies in particular, is currently one of the main concerns for deep sea mining in order to address the major challenges of associated environmental impacts minimisation and mitigation.

Among relevant achievements, the Blue Nodules (https://blue-nodules.eu/), ROBUST (http://eu-robust.eu/), BLUE MINING (https://bluemining.eu/), VAMOS (https://www.vamos-project.eu/) as EU-funded research and innovation projects shall be mentioned.

Recommendations on future policy

Amongst the **policy factors driving innovation**, as stated above, the pressure from environmental protection policies and legislation is crucial for future development of this

Impact on MOBI-US network development

At the first look, it seems that deep sea mining aspect is not of the crucial interest for MOBI-US network development, since involved ESEE countries are geographically positioned between two shallow seas (Baltic and Adriatic) and possible industrial and scientific interest for deep sea mining is not expected. However, listed process and system innovations in this emerging area are expected and eligible for those courses and programmes dealing with broad range of technological mining solutions and equipment development (according to the principle that i.e. system innovation for one involved participant is actually product innovation for another participant in the development process). According to recommendations, involvement of environmental protection participants is expected and even crucial while creating mobility pathways in this field of interest.

Mineral and metallurgical processing

Mineral and metallurgical processing are the steps that follow the mining of metal ores. Before purification of metals through pyrometallurgical and/or hydrometallurgical treatment, beneficiation processes are required to enrich the ore by removing undesired minerals (i.e., gangue). In the case of industrial minerals, beneficiation processes are used to remove impurities and for adjusting the quality of the mineral products.

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Value chain specific context and challenges

Key challenges for mineral and metallurgical processing and drivers for innovation comprise:

(i). improving the overall resource efficiency of processing, i.e. enhanced recovery of valuable minerals and metals with reduced energy and water consumption, and

(ii). minimisation of emissions and residues.

Additional challenges for competitive production arise from (i) the increasing exploitation of deposits with lower grade; (ii) increasingly fine-grained ores; and (iii) a more complex mineralogy. What is more, (iv) combined processing of primary and secondary resources call for adjusted metallurgical processing routes, which is often triggered by adherence to circular economy principles. In addition, (v) complex and time-consuming permitting procedures make it difficult to implement novel processing solutions. An important driver for innovation in mineral and metallurgical processing is the **permanent need for reducing production costs and increasing productivity**.

Innovation types and characteristics

As an efficient production process is paramount to keep production costs low, **process innovation** being the most important type. In addition, **product innovation** also plays a role since the industry needs to develop new products and services, in order to remain competitive. However, the distinction between the two types is not always clear: What a mining company may think of as "**process innovation**" is often "**product innovation**" to an equipment manufacturer. Finally, **organisational innovation** is important, especially in workplace organisation and external relations. In particular, innovation is often a result of collaborative projects among process companies, equipment manufacturers and customers. Innovation in mineral and metallurgical processing is primarily driven by a need for productivity growth, cost savings, and by competition. In addition, the trend towards lower ore grades and more complicated mineralogy drives innovation.

A few innovation trends can be identified in the fields of mineral processing and metallurgical engineering. Since resource efficiency is one of the megatrends driving research, concentrator plants need to develop schemes to produce ever larger concentrate amounts from lower quality feeds, and metallurgical processes have to tolerate or bleed higher amounts of impurity elements. In addition, ever stringent environmental regulations need to be satisfied, while developing strategies to address increased energy costs, water scarcity and waste prevention.

At industrial level, a current strategy to decrease the impact of concentrator plants is the ue of compact designs, which result in lower footprint and capital costs, including less energy consumption. Another aspect of particular interest for the mining industry is the efficient use of water, using smart water management strategies for both existing and greenfield concentrator plants (e.g., H2020 Project ITERAMS).

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New processing technologies are also explored to extract valuables from mineral and waste streams currently considered untreatable. For example, fine particles may contain well liberated valuable fractions but are currently lost into the tailings streams. Consequently, strategies to widen the optimal particle sizes treated by state-of-the-art unit operations is of much interest in industry (e.g., H2020 Project Fine Future).
Finally, there is a strong interest on the re-processing of tailings and other sources of industrial waste. Understandably, these waste streams have the potential of being a vast source of raw materials with relatively simple accessibility. Current technologies for their treatment are not efficient, so new strategies of minerals processing, hydrometallurgy or pyrometallurgy are needed, preferably developed with a systemic perspective. This approach is also in line with the concept of circular economy, of high interest for industry and the general public alike (e.g., H2020 Project CHROMIC)

Recommendations on future policy

The primary drivers of innovation are strongly related to the need of improved productivity with a lower consumption of resources. Public policy plays an important (but secondary) role by setting targets of decreased environmental impact and license to operate in areas where mining activity is carried out or has the potential to be established.

Impact on MOBI-US network development

Mineral and metallurgical mobility pathways within MOBI-US network development should consider mainly product and process innovations, as well as some organisational for implementing within courses and programmes. Again, stated principle that i.e. product innovation for one participant can be process innovation for another, should be considered. Non-policy factors are recognized as the main drivers in this field, but public policy should not be avoided while creating mobility pathways.

Waste management and mine closure

Mining-selected waste (or simply mining waste) can be defined as a part of the materials that result from the exploration, mining and processing of substances. It may consist of natural materials without any modification other than crushing (e.g. ordinary mining waste, unusable mineralised materials) or of natural materials processed to varying degrees during the ore-processing and enrichment phases, and possibly containing chemical, inorganic and organic additives. Overburden and topsoil are also classified as waste. When a deposit's resources are depleted or no longer economically viable, the mine ceases operation. At this point, the final stage

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of site rehabilitation begins. The aim is to remove from the site or neutralise contaminants so that it may begin a new life in a non-mining capacity.

Value chain specific context and challenges

The challenges faced by the extractive industry, in relation to waste management and mine closure, are identified and summarised below:
avoid wastes disposal, with waste minimisation dealing with different methods for waste recovery, and environmentally friendly approaches to land reclamation;
mining wastes reduction through turning wastes into valuable secondary raw materials by developing more efficient recycling/recovering processes (including abandoned or closed mining waste facilities);
proper classification of the waste facilities at the site, where wastes have been deposited according to a common definition of content, volume and comprehensive waste type characterisation;
abandoned/orphan sites rehabilitation; and
new communication tools for raising awareness and building public acceptability.
All these challenges are addressed by identifying the key drivers for innovation. The innovations in Waste Management and Mine Closure are often a result of either the effective policy framework or company's Social Corporate Responsibility Strategy.

Innovation types and characteristics

A **product innovation** example is the invention of a new material or use for a material during the waste valorisation process. **Process innovation** happens when newly improved tools are used, such as advanced software for extractive waste facilities, numerical simulation for safety issues study or environmental monitoring programs. Marketing innovation examples comprise renovated facilities in mine sites, in the end of its economic life, such as the creation of museums, cultural parks, technological centres, etc. An **organisational innovation**, for example, took place in Portugal: DGEG formulated a roadmap to rehabilitate all the closed mines with a clear description in the legal framework and established a subsidised company to execute the rehabilitation plan. In Waste Management and Mine Closure, the policy and regulation framework play a direct role in enabling innovation.

Recommendations on future policy

European and National regulation and mineral policies support the innovative approaches due to the clearly expressed targets for the sustainable development of Raw Materials, the robust environmental regulation, the prevention of waste production and the maximum utilisation of secondary raw materials in the context of the Circular Economy. Thus, a national strategy for abandoned mining site remediation should be based on:

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(i) the identification and classification of the sites that present the highest environmental risk; and (ii). an inventory of both active and abandoned exploration and extraction sites following the example of DGEG rehabilitation roadmap in Portugal.
Public opinion about mining overall, and eventually the Social License to operate (since waste management and mine closure have a significant environmental footprint), is a driving force for innovation in waste management and mine closure.

Impact on MOBI-US network development

For the courses and programmes dealing with waste management and mine closure it is recommended to implement product, process and organisational innovations, as well as recommendations in accordance with stated public policies and strategies, while creating mobility pathways within MOBI-US network.

EU minerals data and minerals policy governance

State of the art in minerals data and statistics in Europe were analysed in MIN-GUIDE project, as well as data coverage, gap analysis and development needs.

State of the art and recommendations on future policy

Governing the secure and sustainable supply of minerals from primary production faces particularly "wicked" dynamics. Mineral policies and governance arrangements address these underlying dynamics, i.e. multiple stakeholder interests, competing land-use interests (e.g. tourism or conservation versus mining), or institutional complexity (e.g. different policy objectives), as they often manifest themselves in market failures, land-use conflicts, and/or lack of societal trust and acceptance of the sector. Recommendations are to establish clear minerals policy framework, streamlined legislations, permitting procedures and minerals data repository for EU MS that provide a holistic view of a more effective minerals policy frameworks. The need to understand the interlinkages between innovation and policy: Policy can both act as a barrier and enabler for innovation, and appropriate governance measures are needed to ensure the effectiveness of policies. In this regard, the analysis of policy impact on innovation in different mining value-chain stages outlined: (i) the need for policy mixes (i.e. applying different instruments types following the same goal); (ii) a long-term strategy and orientation; (iii) avoidance of policy duplication by establishing coordination between linked policy areas and sectors; and (iv) stakeholder involvement.
The following conclusions regarding societal and educational needs were drawn:
(i) the society needs to be well informed of what mining is, and how the raw materials of the products we use in our daily life are obtained in a responsible way. With such background, the public will be in a better position to judge mining projects fairly.

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(ii) we need professionals with skills and leadership on the social aspects related to mining (corporate social responsibility, SLO, mining and wide society learning, etc).
Specific minerals policy governance and national legislatives for networking ESEE countries are listed below (as detected by MIN-GUIDE project), in order to improve possible gaps and needs during mobility pathways network development.

Hungary

The raw materials are state-owned. The Mining Law defines areas 'open' or **'**closed' for exploration. In the 'open' area, exploration is permitted by the regional authorities. In the **"**closed**"** area, exploration is permitted by state authority (ministry) through a mineral concession. The regional mining authorities and some other authorities formed 'Government Offices' (in April 2015), and now the permitting procedure is considered a 'one-stop-shop' (for "open" area). These are one-stop-shop offices, incorporating mining, environment, nature conservation, soil protection, and cultural heritage inspectorates. The permitting procedure (exploration and extraction) for aggregates and industrial minerals may last 1-1.5 years, whereas another 1.5-2 years is needed for metallic ores for the concession procedure or a minimum of 4 years in total). Airborne geophysical methods at small firms and in-situ analysis (oil company, computer tomography) are used from the top 5 ranked innovations in exploration. The national mineral policy is not stimulating for the introduction of innovations in exploration and extraction. The national mineral legislation is too complex and, with that in mind, not stimulating for mining activities in general. There are more and more requirements regarding the EIA procedure. The governance authority responsible for mining activities has too many levels. The permitting procedure for issuing a concession for exploration and extraction of raw materials is time-consuming and long-lasting. There are no national regulations for execution of exploration and developing geological report for deposit characterisation. The national mining regulations/governance (and other regulations affecting mining) should be changed in a way to foster the permitting procedure for issuing concession for exploration and extraction of raw materials. The procedure is currently time-consuming and long-lasting (approximately two years).

Gaps and needs:

- *The local community has too many tools to stop mining operations.*
- *There is no experienced staff in mining and other governance bodies.*
- *The governance authorities (mining and others) are not ready to listen to the academic community.*
- *Streamline and speed up the procedure of permitting for exploration and extraction of raw materials.*
- *The re-evaluation of critical mineral resources is needed.*
- *The execution of national mineral strategy.*

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▪*Reconstruction / reorganisation of mineral governance bodies.*
▪*The integration of the national and local spatial planning systems.*

Poland

The Polish Mining Law was changed to streamline and bring more in line with EU legislation. The changes of mining law affected geological documentation, design of mining project, procedure of permitting and H&S regulations. Getting the concession for exploration and extraction is very difficult. The procedure of land ownership and environmental permitting is very complicated. Mining is a hot topic in Poland, mainly because of coal and underground mining safety issues, which impacts all other mining too. There is no active policy support for mining and no real exploration happening at the moment. Plans for open mines have been stopped and lot of geological work has stopped as well. The top 10 ranked innovations in exploration and extraction are mainly driven by business decision. The introduction of any innovation needs approval of the authorised mining plan, H&S considerations play a big role in updates, i.e. improvements should be positive. Drones are used in active mines for surveying. The aviation law requires special license for implementation of drones. The Polish mining company KGHM is doing some testing of autonomous equipment. The introduction of autonomous equipment in extraction needs mining authority approval. The simplification of permitting and concession procedures would be helpful (expert sees Slovakia or Belgium as positive examples). Future policies must make mining more attractive. There is no national mineral policy (strategy) in Poland. The governance authority responsible for mining activities in Poland is not well-structured and efficient because responsibility is divided between too many institutions. The biggest problem regarding extraction and processing activity concerns waste management. The national mining regulations/governance (and other regulations affecting mining) must make better access to mineral deposits possible. There is spatial conflict in many places with deposits, as well as no social acceptance. There is lack of mineral policy concerning mineral protection in Poland.

Croatia

Mining in Croatia lacks a feasible legal and procedural framework as an important prerequisite for the development of the mining sector. The Mining law is a state law applicable to the entire Croatian territory. The new mining act was passed in Croatia in 2013 (Official Gazette 56/13 and 14/14.), which, with its unique 4-step procedure, greatly simplifies the permitting procedure and is therefore stimulating for mining activities. In the case of investigation, national related policies do not affect innovation in exploration. The national mineral policy is not stimulating the introduction of innovations in mining. The national mineral policy is stimulating mining activities in general. The governance authority for mining in Croatia is dual (two Ministries). The jurisdiction over minerals is currently shared by two government bodies: Ministry of Economy, Entrepreneurship and Crafts deals with all issues related to solid mineral raw materials, while

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Ministry of Environmental Protection and Energy is in charge of permitting processes for energy mineral raw materials. The governance authority responsible for solid mineral raw materials is adequately structured and moderately efficient. It is recommended that some potential critical raw materials are explored using modern and innovative technologies.

Gaps and needs:

▪*It is necessary to incorporate provisions on stimulation of innovation into acts and ordinances related to mining activities, and provisions on exploration and extraction suitable areas into the Physical Planning Act and Building Act.*

▪*Currently no innovations are mentioned in the legislation, but in the future, it could be possible, through new ordinances, to encourage innovation for the purpose of better and efficient exploration and extraction of raw materials.*

▪*As mining activities are also dependant on legislation other than the Mining Act (Physical Planning and Building Act), it is prerequisite to determine areas suitable for exploration and extraction and incorporate them in state and counties' spatial plans.*

▪*However, implementation of new technologies (infrastructure and IT services to achieve service delivery, GIS-based system that promotes efficient administration) is needed.*

▪*A new regulation for classification and accompanying regulations on resources/reserves of solid raw materials is in the making.*

▪*Innovations are not in any way mentioned in the national mining related policies, though we feel that innovations would be welcome. Other policies do not mention innovations either. The implementation of new technologies (infrastructure and IT services to achieve service delivery, GIS-based system that promotes efficient governance administration) is needed.*

▪*A new strategy for mineral resources in Croatia should be developed.*

▪*The mining law must protect raw material resources (from other land users).*

▪*Overarching there is a social unacceptance of mining activities (NIMBY syndrome) and there is a public perception of mining activities as nature and environmental devastators.*

▪*Streamline and speed up the permitting procedure, especially the EIA procedure.*

▪*Better coordination of state authority involved in procedure of permitting (mining governance body, physical planning governance body, environmental and nature protection governance body).*

Impact on MOBI-US network development

National legislative framework and minerals policy governance should be taken in account while creating any possible mobility pathway in MOBI-US network. Programmes and courses should consider societal and educational needs, specially stated “need for professionals with skills and leadership on the social aspects related to mining”.

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Circular economy and recycling

Environmental problems, such as biodiversity loss, resource depletion, excessive land use, and water-, air-, and soil pollution are increasingly threatening to destabilise the Earth's biophysical systems. To address such sustainability challenges in an economic system where growth is associated with a 'take-make-dispose' paradigm, there is a pressing need to transition to more sustainable societies and systems of consumption and production. One approach to address flawed structures of market externalities within a finite system of resources is the concept of Circular Economy (CE).

The CE strategy sets ambitious targets in a number of areas that are facilitating the move towards a circular and sustainable economy. Key elements of the strategy include **revised legislation on waste**, which supported **recycling of municipal and packaging waste**, **reduction of landfill** (and promotion of economic instruments to discourage landfilling), **harmonised and improved calculation methods for recycling rates** throughout the EU, concrete **measures to promote re-use and stimulate industrial symbiosis** (turning the by-product of one industry into the production input of another), as well as economic incentives for producers to put greener products on the market. *The report on critical raw materials and the Circular Economy* highlights the potential to minimise supply risks of the 27 critical raw materials (CRMs) through circularity and substitution.

Value chain specific context and challenges

MIN-GUIDE results address the aspect of resource efficiency in fostering circularity through in-depth understanding of good practice innovation cases in the EU throughout the mining value-chain (www.min-guide.eu). By explaining innovation processes and respective sustainability impacts, as well as the contextual factors contributing to innovation (e.g. policy, financial, etc.), it promotes an understanding and potential transferability of innovations that contribute to circularity within the mining value chain. Examples of innovation fostering circularity were also identified in e.g. practices of mine-closure. The attempt for double reuse, the development of museum spaces coexisting with new scientific and research spaces, was the central idea of planning. This example differs from the 'process optimisation' that often is coupled with CE to encompass innovations within a broader sustainability approach and including social dimensions, which also may contribute to a circular and more sustainable economy.

Innovation types and characteristics

Optimisation of processes and increased recycling and reuse of raw materials are important and integral steps of transitioning to a circular economy. However, the need for virgin materials and primary production to foster technological innovations and a circular economy still remains high, as the supply of secondary resources (i.e. recycling of waste) still remains relatively low in the EU.

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The effort to attain a secure and sustainable supply of raw materials is promoted through two of the three pillars of the Raw Materials Initiative, i.e. increasing supply from European sources and ensuring sustainable and secure sourcing of minerals on world markets. MIN-GUIDE investigated also effective policy frameworks that foster innovative and sustainable solutions for a mineral supply from EU sources according to the second pillar of the RMI.

Recommendations on future policy

The transition to a Circular Economy may see the emergence of increased value-chain integration (mining with other parts of the raw material value chain) etc., to promote closed-loop production systems. As highlighted by the EU Commission, and shown by the MIN-GUIDE results, the intrinsically linked nature of raw materials to an array of industry and policy sectors further calls for cross-sectoral and stakeholder integration to achieve policy coherence, legitimacy and awareness: This applies both to the strategic policy agenda and circular economy package, and equally so to more narrowly framed policy agendas, such as industrial manufacturing or WEEE recycling. Thus, the need for policy instruments facilitating innovation, long-term strategies, ministerial collaboration, policy integration and coherence is interlinked with the objective of transitioning to a sustainable, circular, low carbon, resource efficient and competitive economy.

Impact on MOBI-US network development

MOBI-US network development and mobility pathways oriented toward circular economy (CE) and recycling will be affected by all types of innovations. Public policies and strategies will play important role in this field of interest and it should be strongly taken in account while creating mobility pathways.

4.4. Conclusions and recommendations

As the contribution in Structured Mobility Guideline for MOBI-US network development, main industry trends and policy perceptions in the ESEE region concerning the raw materials are summarized, according to the results of the MIN-GUIDE project (www.min-guide.eu). Main emphasis is given to mining, minerals and recycling related issues and to materials engineering ones.

For MOBI-US network development and creating mobility pathways within, it is suggested to consider and use the following topics and trends: (i) Value chain specific context and challenges; (ii) Innovation types and characteristics, (iii) Recommendations on future policy.

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Innovations of different types were recognized and described as driving factors in the following fields: (i) Exploration and extraction; (ii) Deep sea mining; (iii) Mineral and metallurgical processing; (iv) Waste management and mine closure; (v) EU minerals data and minerals policy governance; (vi) Circular economy and recycling. Alongside the analysis and identification of items from MIN-GUIDE, this report contains a set of recommendations and conclusions (entitled in all subchapters as *Impact on MOBI-US network development*) for the proper knowledge transfer from MIN-GUIDE and the implementation of important items in the MOBI-US project activities.
Here are listed *Impacts on MOBI-US network development* which are recommended to implement in MOBI-US network mobility pathways, for all described field of interest:

Exploration and extraction

For MOBI-US network development it will be crucial to implement different types of innovations within courses and programmes while creating mobility pathways. For the courses and programmes dealing with exploration and extraction of raw materials it is recommended to involve industrial partners suitable for implementation of abovementioned innovation types (mainly process and system, as well as some product innovations) and recommendations in accordance with stated policies, strategies and societal issues.

Deep sea mining

At the first look, it seems that deep sea mining aspect is not of the crucial interest for MOBI-US network development, since involved ESEE countries are geographically positioned between two shallow seas (Baltic and Adriatic) and possible industrial and scientific interest for deep sea mining is not expected. However, listed process and system innovations in this emerging area are expected and eligible for those courses and programmes dealing with broad range of technological mining solutions and equipment development (according to the principle that i.e. system innovation for one involved participant is actually product innovation for another participant in the development process). According to recommendations, involvement of environmental protection participants is expected and even crucial while creating mobility pathways in this field of interest.

Mineral and metallurgical processing

Mineral and metallurgical mobility pathways within MOBI-US network development should consider mainly product and process innovations, as well as some organisational for implementing within courses and programmes. Again, stated principle that i.e. product innovation for one participant can be process innovation for another, should be considered. Non-policy factors are recognized as the main drivers in this field, but public policy should not be avoided while creating mobility pathways.

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Waste management and mine closure

For the courses and programmes dealing with waste management and mine closure it is recommended to implement product, process and organisational innovations, as well as recommendations in accordance with stated public policies and strategies, while creating mobility pathways within MOBI-US network.

EU minerals data and minerals policy governance

National legislative framework and minerals policy governance should be taken in account while creating any possible mobility pathway in MOBI-US network. Programmes and courses should consider societal and educational needs, specially stated “need for professionals with skills and leadership on the social aspects related to mining”.

Circular economy and recycling

MOBI-US network development and mobility pathways oriented toward circular economy (CE) and recycling will be affected by all types of innovations. Public policies and strategies will play important role in this field of interest and it should be strongly taken in account while creating mobility pathways.

4.5. References

Endl, A. et al., 2018. *The MIN-GUIDE Policy Guide - Guidance for EU and MS mineral policy and legislation*, Deliverable 1.3, 46 p. H2020 MIN-GUIDE (Minerals Policy Guidance for Europe) Project, Grant Agreement: 689527.

Vrkljan, D. et al., 2018. *Innovative Processing*, Deliverable 4.3, 27 p. H2020 MIN-GUIDE (Minerals Policy Guidance for Europe) Project, Grant Agreement: 689527

Minerals Policy Country Profile- Hungary, 12p. H2020 MIN-GUIDE (Minerals Policy Guidance for Europe) Project, Grant Agreement: 689527.

Minerals Policy Country Profile- Poland, 9p. H2020 MIN-GUIDE (Minerals Policy Guidance for Europe) Project, Grant Agreement: 689527.

Minerals Policy Country Profile- Croatia, 30p. H2020 MIN-GUIDE (Minerals Policy Guidance for Europe) Project, Grant Agreement: 689527.

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5. Chapter 5: Latest results on European qualifications framework, skill and competence catalogue for the raw materials sector

5.1. Executive Summary

The "Guideline document compilation" work package aims at providing a guideline material for the networking universities in order to help the efficient partner finding and the preparation of documentation background for linked programmes. This report contributes to this goal with an analysis on the European qualification framework used by academia, as well as with information on a skill and competences catalogue for the raw materials sector, which are supported by analysis on the gaps and needs of the Raw Materials industry that are going to shape the education and training of students and professionals in the near future, to which MOBI-US network will be part of.

This task takes its roots in the INTERMIN project, where the groundwork was already developed. An analysis on the work done during this project and that is of relevance to MOBI-US is done, and conclusions for the MOBI-US implementation are drawn, which will lead to the chapter to be included in D1.6. MOBI-US is suggested to use the following topics previously studied in INTERMIN (knowledge transfer):

a) The skills catalogue developed for the raw materials sector,
b) Report on skill gaps in the sector,
c) Integrated competency model for employment across the raw materials sector, and
d) International qualification framework for the raw materials sector.

Alongside the analysis and identification of items from INTERMIN, this report contains a set of recommendations and conclusions for the proper knowledge transfer from INTERMIN and the implementation of important items in the MOBI-US project activities.

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5.2. Introduction

The main goal of this chapter, and WP1 as a whole, is to support the networking partners of MOBI-US with a set of guidelines to help them prepare the master courses and establish fruitful mobility programmes while ensuring a continuation of implementation after the project's aftermath. In the specificity of this report, the aim is to provide insights on the skills needs of industry and make the bridge between education and industry in the raw materials sector. This can be achieved by introducing efficient teaching solutions in the master programmes while at the same time support the mobility schemes with partner searching and refinement of the mobility window courses offered in the home programmes of ESEE universities. The guidelines of this deliverable are, therefore, essential for a good implementation of MOBI-US and shall be aligned with the guidelines provided by the remaining WP1 deliverables. The focus given to mining, minerals, recycling and materials engineering issues are incorporated in the developed work as they are transversal to the raw materials education courses offered.

This deliverable (also called chapter as per Project Agreement) reflects on the findings of the Horizon 2020 project INTERMIN (www.interminproject.org, Grant Agreement No. 776642) on the skills, gaps and related issues for the raw materials sector. It is based on reports from Work Packages 1 (Worldwide mapping of educational-research programs), 2 (Raw materials sector skills, gaps and needs) and 3 (Towards enhanced training programs). The following INTERMIN deliverables were screened:

- D1.1 – Skills catalogue for the raw materials sector (Regueiro and Jordá, 2018)
- D2.1 – Report on skills gaps (Konrat Martins and Bodo, 2019)
- D2.2 - integrated competency model for employment across the raw materials sector (Konrat Martins et al., 2019)
- D2.3 - Roadmap on skills provisioning for the raw materials sector (Konrat Martins and Bodo, 2019)
- D3.1 - international qualification framework for the raw materials sector (Correia et al, 2019)

The above-mentioned work packages focus on different, but altogether relevant aspects for the raw materials sector: current and future skills, competence gaps, qualification frameworks, raw materials education and training, knowledge needs, employment, among others. The outcomes

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are fairly important to the education system, especially adequate for higher education levels (such as masters programmes), as well as to the industry. In a changing field, where future employees (current and future students) will need to acquire and adapt skills and competences, the education system needs to adjust to the future requirements of the industry. When the needs of MOBI-US are put into scope, one can agree that the INTERMIN project has a good source of groundwork that can be used for the benefit of this project, leveraging the knowledge transfer between European projects. Competence development assumes particular relevance in the scope of the project.

Based on current and future skills and gaps in competences for the raw materials sector industries, a set of level descriptors for the raw materials education system was suggested. This is based on three areas of high interest: 1) mineral exploration, 2) mineral extraction and processing and 3) material engineering and recycling. Despite having level descriptors for different levels, in this document only the ones that important for the MOBI-US project are transcribed, i.e., the ones that are translated to the master's Programmes levels (level 7 in EQF system).

Due to the specificity of the raw materials sector, INTERMIN suggests the introduction of a new classification framework (substituting the actual EQF in place in Europe). This framework, the "sectoral qualifications framework for the raw materials sector" (SQF-RM) is designed to work worldwide, which strengthens adaptability and mobility of education programmes, such as the aim of MOBI-US. This framework has its roots in the EQF.

Figure 5.1 displays what are the main inputs used from INTERMIN's results and outcomes, how they, when analysed, contribute to the development of this deliverable, which, in turn, contributes to the creation of D1.6, the Guideline Document for the network partners of MOBI-US.

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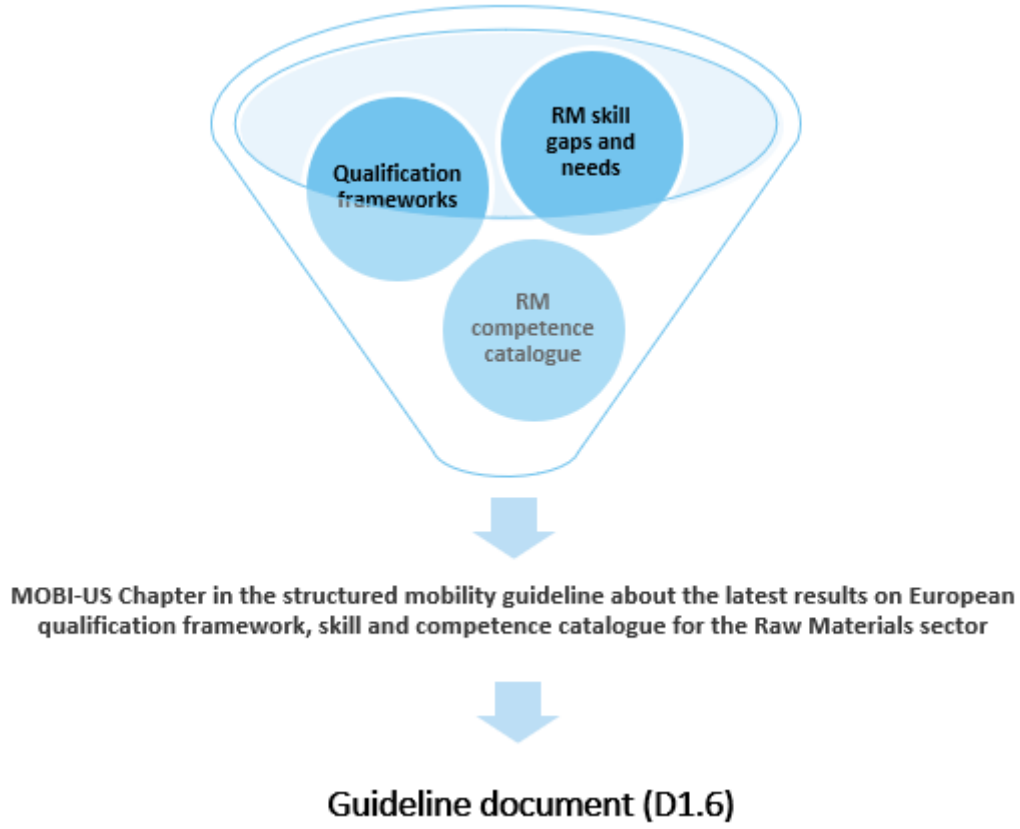

Figure 5.1: Inputs for Deliverable 1.5 and relation to Deliverable 1.6

5.3. The INTERMIN project outcomes and knowledge transfer to MOBI-US

The INTERMIN project - International Network of Raw Materials Training Centres – is aiming at creating and fostering a network of training centres for the raw materials sector, that together with the higher education systems can help the future workforce (current and future students) to be prepared for the changing raw materials sectors' fields. Industry is already lacking some skills and competences in its employees and, therefore, is calling and supporting changes in the education system to fit its needs. Industry is, in fact, a crucial driver for the education system and for MOBI-US as it is industry that ultimately drives what skills and competences are taught and given to students. MOBI-US acknowledges this fact and will involve the ESEE raw materials industry in the project activities.

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As INTERMIN studied and analysed, many of the topics that are relevant for the implementation of MOBI-US, some of its most relevant results and outcomes are suggested to be applied in this project, and they are quite transferable and adaptable to the mobility programs as they try to cover important needs in the education systems of universities in the ESEE region. The most relevant outcomes transferable to MOBI-US lie in:

a) The skills catalogue developed for the raw materials sector (D1.1)
b) Report on skill gaps in the sector (D2.1)
c) Integrated competency model for employment across the raw materials sector (D2.2), and
d) International qualification framework for the raw materials sector (D3.1)

Each of these deliverables/main topics result in the subsequent four sub-chapters of this deliverable. The main outcomes of this chapter and sub-chapters can be seen as recommendations fit within Chapter 4, which will lead to the final chapter to be included in D1.6.

The skills catalogue developed for the raw materials sector

INTERMIN developed a skills catalogue for the raw materials sector, which includes an extensive list of skills, competences and knowledge currently offered by education and training centres in many areas of geosciences at international level (although with focus on Europe). More than 180 institutions and more than 370 programmes related to raw materials are part of such list. As an example, all the networking partners and masters programmes involved in MOBI-US are part of this list and their skills and competences offered were analysed. These are available on a free online platform (https://interminproject.org/preliminary-survey-results/) resulting from an extensive survey.

The previously mentioned tool offers the possibility to study the offering of respective raw materials skills and training in different countries, universities, regions, and languages. Due to its extensiveness, this is a tool that can be used by the MOBI-US networking partners to assess possible universities and/or training centres of the ESEE region as collaborators for the implementation and extension of the project's mobility programme. The main outcome of this work is contained in INTERMIN's D1.1 and in the referred public online database. The importance for MOBI-US lies in the list of skills offered by the ESEE universities and training centres. The database offers the perfect pool of potential candidates for the extension and integration of the mobility programs.

The following list of items contains the key elements/knowledge bits that shall be transferred from INTERMIN and applied in MOBI-US, on the skills catalogue (based on INTERMIN's deliverable 1.1).

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The implementation of these items shall help the success of MOBI-US in making a fruitful mobility program:

1) Streamlining vocabulary (definitions) and establishing a MOBI-US threshold for common language;
2) Scope: ensuring gender balance and comprehensive scope at the masters programmes levels across ESEE current and future networking partners;
3) Assessing skill shortages and the kind of professionals the raw materials industry is looking for;
4) New skills and sustainability of the skills catalogue from INTERMIN to implement to MOBI-US, such as
    a. Environmental concepts,
    b. Computing,
    c. Advance in robotics and automation,
    d. Social aspect in mining and industry.

MOBI-US vocabulary

Intervening in both fields of raw materials industry and education, the MOBI-US project deals with a number of vocabulary items that will be used transversally to most project activities and across different partners. In order to maintain a common approach, the following vocabulary is suggested to be streamlined:

- Skills;
- Competences;
- Knowledge;
- Gaps;
- Capacities;
- Subject;
- Course;
- Programmes;
- Qualifications;
- Learning outcomes;
- Mobility (pathways).

Note that items in red (skills and competences) are more likely to be subjected to see their meaning changed in each university/networking partner due to their specificity. Therefore, it is crucial for

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MOBI-US to ensure a minimal threshold for any definition applied. This threshold will not only ensure clarity for students and course/programme coordinators but will also ensure that any student can be certain that the skills and competences he or she will acquire during his or her exchange period can be accepted as valid ECTS. If definitions of any given item of the aforementioned list or any definition used for MOBI-US meets discrepancies in any of the partners universities, uniformization of the vocabulary should be implemented, as shown in Figure 5.2:

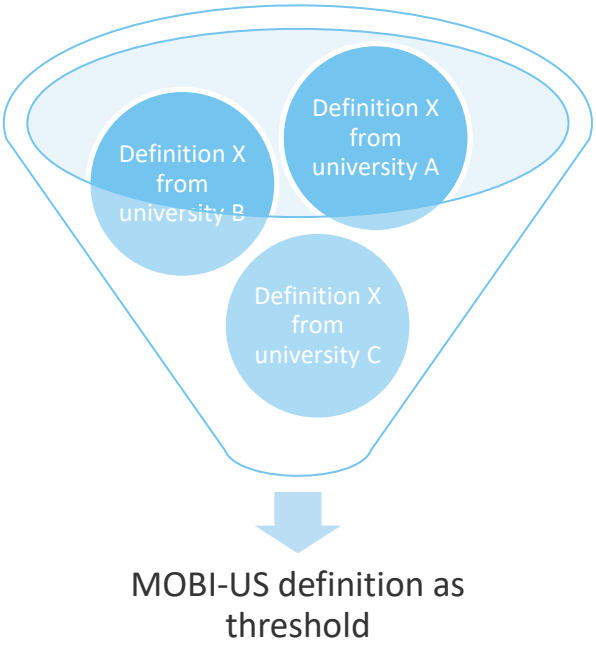

Figure 5.2: MOBI-US needs to employ a standard, common definition within its structured mobility programs

Scope

MOBI-US shall assess the need of the industries to fit the most relevant education and training to the students during their exchange, covering possible gaps. This assessment shall be continuous as the needs and demands of the industries are in constant evolution, therefore education should follow this evolution to better prepare the future workforce.

MOBI-US may also see fit to expand the scope of profiles in its exchange programs to encompass other geosciences disciplines. In addition, gender equality is an important social issue nowadays. The new, Von Der Leyen Commission placed gender equality on top of the political agenda, notably

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by establishing gender balance among commissioners. Considering this, MOBI-US shall promote gender equality among its exchange students. This could be achieved by taking inspiration from the ENGIE project (https://www.engieproject.eu/), whose aim is to turn the interest of females to study geosciences and geo-engineering, and thus to improve the gender balance in the fields of these courses. The project will develop an awareness-raising strategy and create a stakeholder collaboration network for the implementation of a set of actions in more than 20 EU countries, including ones in the ESEE region. The project envisions attracting more young women to the raw materials related scientific and engineering sectors.

MOBI-US program shall promise to be an equal opportunity program. Said mandate could take the following structure:

"MOBI-US does not and shall not discriminate on the basis of race, colour, religion, gender, gender expression, age, national origin, disability, marital status, sexual orientation, or military status, in any activities or operations. These activities include, but are not limited to exchange programs, counselling; selection of students and provision of services. We are committed to provide an inclusive and welcoming environment for all members of the projects, partners and exchange students.

[signature of the project coordinator]
[signature of representant of University A]
[signature of representant of University B]
[signature of representant of University C]
[signature of representant of University D]"

Based on this declaration – or any other of similar nature-, proof of this mandate shall be kept under the form of a spreadsheet proving balance. If this spreadsheet is approved by project partners, it shall be crucial to respect GDPR and students shall be able to give their consent to see their data (but excluding their name and private details) used for a statistical survey. Items covered by this survey may include, but are not limited to:

- Gender (according to the LGBTQIA+ nomenclature and including a "rather not say" option);
- Age (including a "rather not say" option)
- Field of study and degree
- Ethnicity (including a "rather not say" option)
- Religion (including a "rather not say" option)
- Prior experience with Erasmus+ or other exchange programs
- Would you apply for another exchange program?
- How would you rate the MOBI-US project?

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A simple survey of this nature could help MOBI-US to better understand and steer the mobility programs in order to achieve a fruitful outcome.

Skill shortages and raw materials professionals

Skills shortages in any field are linked to foresight and drawing a timeframe in which a specific set of skills will be in demand (Figure 5.3). In addition, matching demand of skills with its demand. Matching offer and demand not only ensures a proper matchmaking with the industry but also ensures jobs to prospective students and the insurance they will not overflow a low demand sector or let a high demand sector on the side by being misinformed at the start of their studies, during their studies or at graduation.

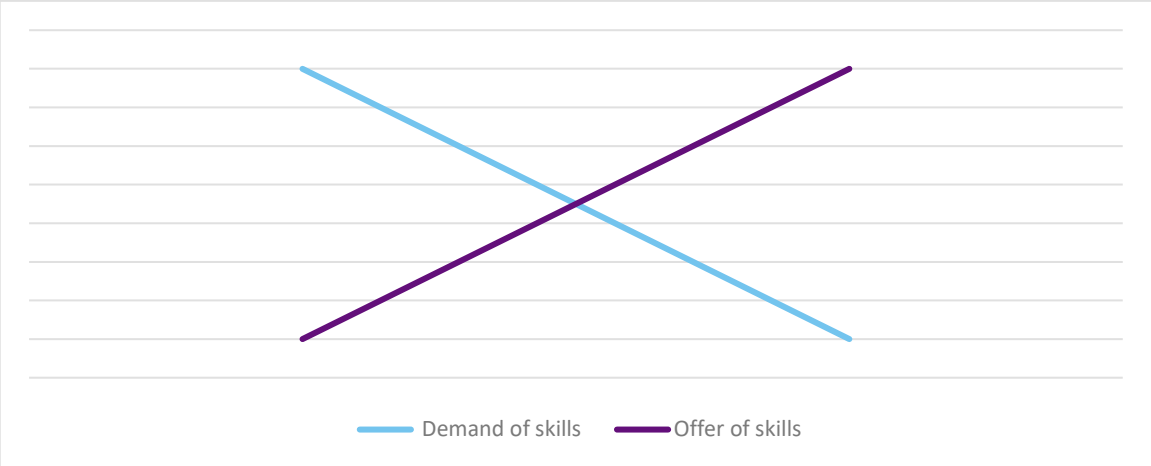

Figure 5.3: Theoretical model of offer and demand of skills in Raw materials before assessment

Shortage in skills and competences are a common problem of a lot of European industries and so much more in the raw materials sector. This has already been acknowledged as one of the major challenges facing the industry globally as well as in Europe (referenced in the Raw Materials Scoreboards[1] from the EC, for example). The same conclusion can be taken from Ernst & Young's annual reviews of the mining and metal industry business risks (as for example in their 2019 assessment). It their analysis they ranked skills shortages as the main risk faced by the mining industry, which are driven by technological advances, cyclicity and demographics.

[1] https://op.europa.eu/en/publication-detail/-/publication/117c8d9b-e3d3-11e8-b690-01aa75ed71a1

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Regarding skills shortages, INTERMIN also identified the need of the so-called **T-shape professionals** (Figure 5.4; Definition: T-shape professionals are characterized by their deep disciplinary knowledge in at least one substance area and capability across the boundaries between disciplines) **in the raw materials sector industries**. Therefore, it is advisable for the mobility courses to **include skills development** that fit into the scope of a T-shaped professional. This kind of professionals is already in high demand for their ability to innovate, build relationships, advance research and strengthen their organization, and many industries are already preferring these types of workers.

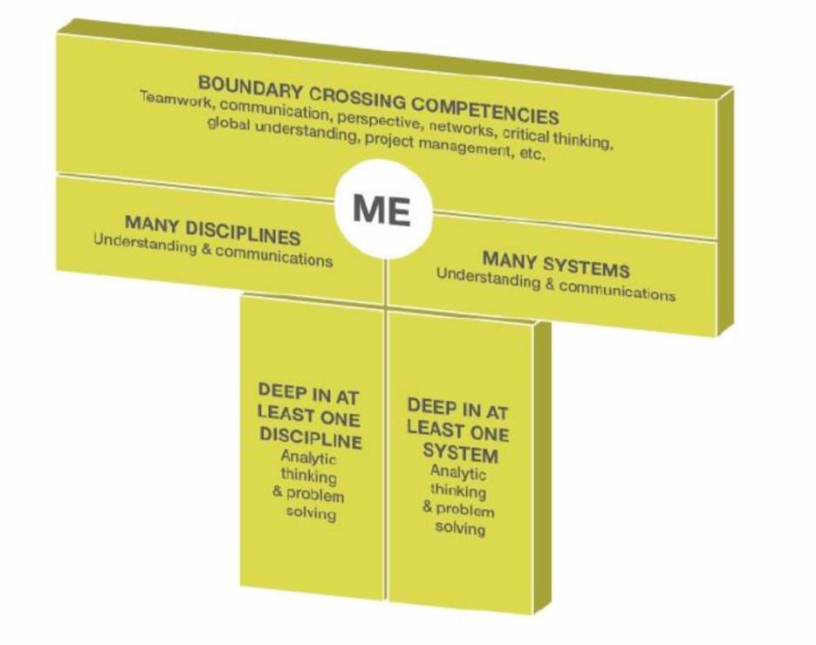

Figure 5.4: Characteristics of a T-shaped professional (source: www.tsummit.org)

T-shape professionals are becoming common sight in the working environment. INTERMIN concluded that employers are placing increasing importance on skills that go beyond a single discipline. However, there are some barriers for the "shaping" of students:

- Researchers receive strong focus on technical excellence but very little on "soft" skills.
- Lack of practical training and cooperation with industry.
- Lack of improvement of employability skills in technical universities.
- Low number of policies supporting collaboration between universities, research centres and industry.

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It is of relevance for MOBI-US to **guarantee that the exchange and mobility programs will follow the value of T-shape professionals** as they are an attractive and high demand commodity on the job market. The T-shape approach shall improve on some requirements including, but not limited to, new systemic innovations in areas of waste reduction, recycling, material efficiency and residue utilization. It is also necessary that professionals have a deep understanding of the raw materials system and the entire value chain. These requirements are transversally important to academia, industry and research alike. However, most of the education and training offered in the raw materials spectrum focus on only one field.

New skills and competences for the raw materials sector

Although classically considered as "conservative", the mining industry did develop new skills in the last decade of the 20th century, a trend that is seen nowadays as well. These are skills that relate to the overall of the raw materials value chain. For MOBI-US they are of special importance on three areas: 1) minerals and mining, 2) recycling and 3) materials engineering.

Table 5.1 discloses the most relevant skills and assess whether or not they are still relevant today.

Table 5.1: New skills for the raw materials sector and their relevance in 2020

Skill	Current Relevancy
Introduction of the **environmental concepts**. Environmental impact studies and specific regulations for the closure of mines from the 1980's. Initially there was a lot of reluctance and it was difficult to introduce these concepts in the industrial sectors, however the inclusion of environmental aspects in the business plan of a company and as a skill is already a consolidated reality.	**Particularly relevant** in the context of the Green Deal.
Computing, new technologies and the internet. Since the 1990's it is an indispensable skill in technical studies and these are fully consolidated.	**Particularly relevant** with the growing importance of computer engineering.
Advances in robotics and automation. Emerging skill that is usually learned in the workplace.	**Particularly relevant** with the growing importance of computer engineering.
Social aspect in mining and industry, licensing and public awareness. Many mining projects in Europe (in	**Particularly relevant** with the current need for Social License to Operate

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particular) having passed all the technical, legal and environmental filters, are being blocked by social disconformity. It can be said, without a doubt, that the social license to operate (and everything related to NIMBY) is the Achilles heel of the extractive industry in Europe and many countries of the world, thus it has become a very relevant emerging skill.	that mining companies must adhere to

All of the above-mentioned recent skills needed for the raw materials industry have some degree of importance in the current and future panorama for the raw materials sector and should, therefore, be fostered in the education and training of raw materials professionals. In the light of the MOBI-US mobility programs.

Skills and competences gaps in the raw materials sector

To assess the skill and competences gaps in the raw materials sector, the INTERMIN project followed a three steps approach with three different timelines on focus:

- Short-term skills gaps (Horizon Europe; data collected through desk research)
- Medium-term skills gaps (2030; data collected with the help of focus groups sessions)
- Long-term skills gaps (2050; data gathered thanks to a two-stage Delphi survey)

In addition to this methodology, MOBI-US shall implement the results of the INTERMIN survey. The results came out on January 2019; therefore, they are relevant in the MOBI-US context. In addition, using past results can save time and effort, thus increasing the time and money efficiency of the whole project. It is recommended to follow INTERMIN's classification of gaps as coherence between EU-funded projects dealing with similar fields might result in greater coherence and support to raw materials policies at large. Said coherence could prove useful for readers/stakeholders familiar with INTERMIN for them to better understand the goals and benefits of the MOBI-US project.

The following section will detail the list of gaps seen for geoscientific fields for the three-time horizons: short, medium and long. They are all of importance for the implementation and sustainability of the MOBI-US project and its mobility programs.

Short-term skills gaps (Horizon Europe panorama)

INTERMIN defines short-term skills gaps as: "Immediate needs in terms of skills and competencies are expected to fit within the present-day trends in the raw materials sector (…).". Given this

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definition, it is then crucial for MOBI-US to place these skills at the forefront of its programs as these gaps are currently in demand in the raw materials industry and should be solved first. Meeting the demand of skills will not only ensure the relevance and efficiency of MOBI-US but will also enable students to enter the job market with confidence, which will support the ESEE raw materials industries.

The following skill gaps were presented by the INTERMIN project thanks to the results of *WEF (2016) and MGI (2018) reports.* These skills are:

- Physical and manual skills
- Basic cognitive skills
- Higher cognitive skills
- Social and emotional skills
- Technological skills
- Abilities
    - Cognitive abilities
    - Physical abilities
- Basic Skills
    - Content skills
    - Process skills
- Cross-functional Skills
    - Social skills
    - Systems skills
    - Complex problem-solving skills
    - Resource management skills
    - Technical skills

Such categories are used to identify across different occupations where positive and negative changes are expected to occur and relate to the observed drivers for specific industry, geographies and other factors The research done by MGI (2018) in the Energy and Mining sector shows an expected increase in demand for higher cognitive skills, social, emotional and technological skills expected for the next years. In other words, skills related to quantitative and statistical abilities, critical thinking, complex problem-solving and creativity are expected to increase in demand, while basic cognitive skills such as basic data input and processing are likely to decrease due to the increase in automation. The 'Mining & Metals Industry profile' by WEF (2018) projects on the short-term, based on companies surveyed, a move towards augmented machine-based share of job tasks in relation to humans (10-30% of share of task hours). The survey also projects the emergence of roles such as 'new technology specialists', 'data analysts and scientists', 'big data specialists', 'AI and Machine Learning specialists' and 'systems engineers', among other. On the other hand, roles such as 'plant operators', 'management and organisation analysts' and 'extraction workers' are expected to decline by 2022.

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The OECD (2016) also highlights that future of work will be marked by a decrease in routine tasks with growing emphasis on skills that cannot be automated. In that sense, 'soft skills' can gain in prominence, such as the ability to communicate in diverse settings, work in teams, and solve complex problems. This, however, does not preclude a rapid rise in demand for ICT (Information and Communications Technology) specialist skills, which in turn points to an increased potential risk of skills mismatch. Such gap may be more acute in emerging economies (WEF, 2017).
On top of desk research and conclusions of universities, it is important to assess industries' demand to coordinate supply accordingly. Research suggests that industries tend to invest in re-skilling of current employees, support mobility and job rotation, increase collaboration, target and attract female and foreign talent, among other. This first point is particularly relevant for MOBI-US as employees are to meet new requirements rather than companies to invest in new hiring (e.g. fresh graduates).

Mining & Metals Industry analysis points out the main strategies raw materials companies need to tap into:

- Retrain and upskill
  - Imperative for companies to compare their current skills base against the skillsets that will be needed in the near future
- New retention and attraction strategies
  - Due to scarcity and high competition for tech-savvy professionals
- Source and integrate talent across networks
  - By attracting talents from other sectors and industries
- Redesign work for technology and learning
  - Identify areas where digital technology can translate into better worker performance
- Create new social contracts with communities and governments
  - Mitigate new labour dynamics in relation to local, regional and even national communities and governments

In addition, the widespread digitalization of society will push companies to compete to hire the best technician and ICT specialists to remain on top of the competition. Finally, the raw materials sector is set to see a shortage in mentorship positions.

WEF (2018) listed 10 trends shaping overall industry growth:

1. Increasing adoption of new technology
2. Advances in devices bridging the human-machine divide
3. Advances in new energy supplies and technologies
4. Advances in Artificial Intelligence
5. Shifts in national economic growth
6. Expansion of education

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7. Expansion of gender parity
8. Increasing availability of big data
9. Shifts in global macroeconomic growth
10. Advances in cloud technology

More recently, a report commissioned by the Minerals Council of Australia (MCA) and Ernst & Young (2019) suggests that technological innovations will impact work in the whole raw materials value chain – from exploration to trading (Table 5.2):

Table 5.2: Short-term skills requirements for the mining value chain

Mining value chain storage	Workforce impact and skills required
Exploration	• Reduction in drilling operators due to automation • Increased demand of analytics and modelling skills • Increasing share of remote work
Mining Operations	• Reduction in drilling operators due to automation • Key skills shift from technical execution to decision support focus • Emerging roles: 'systems engineering' and 'data scientists' • Increasing share of remote work • More complex problem-solving thinking ability to anticipate and plan activities • Managing human-to-machine interfaces • Advanced systems development and integration
Processing	• Increase in advanced analytics and 'big data' applications – i.e. 'data scientists'
Transport	• Upskilling of operators to manage human-to-machine interfaces • Advanced systems development and integration – management of autonomous systems and shipping platforms
Trading	• Shift on the operating model from mining based on volumes to mining based on quality and customer requirement focus.

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End-to-end	• Dealing with increased complexity of planning, scheduling and advanced decision-making – complex systems management for end-to-end optimization • Technical modelling and advanced geological and geo-spatial capabilities.

Medium-term skills gaps (2030 panorama)

Previsions for short-term skills gaps are likely to remain relevant for medium-term (due to the short timespan between the two considered horizons). Specifically, in-house training of employees is set to become even more common. The T-Shaped professionals mentioned in the previous section are set to become trending too. In addition, reports suggest that the key items relevant for foreseeable future lie in:

1 Moving away from getting “bigger and bigger” or “bigger is better” and economies of scale - in other words, rethinking approaches to develop mineral deposits; focus on small and difficult to access deposits
2 Social issues are becoming the main challenge for the mining industry for the next 10-15 years, and Social License to Operate will assume even more importance.
3 Increase in online courses and training in raw materials – though not every skill/competence may be acquired online.
4 Progression of integrated teams to integrated professions, where skills deployment turns more agile.
5 More companies seeing themselves as ‘Raw Materials companies’ – in response to ongoing sectoral dialogues and programmes such Horizon 2020 and Horizon Europe.

Long-term skills gaps (2050 panorama)

This list of requirements for young professionals has been obtained thanks to research and a Delphi survey. The following statements are recovered from the INTERMIN Delphi Survey. Only Statements which had a majority of “agrees” will be featured as they are the ones who reached positive consensus among the expert participation. Wherever necessary, comments will support the explanation of the statements.

- While conventional mining will evolve to deeper and larger open-pits and ultra-deep underground operations ('supercaves'), it will co-exist with novel, not yet developed mining methods.
- By 2050, the majority of mine sites will be fully autonomous operations”

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  - While most respondents were on the agreement side in the first round, some scepticism was observed regarding the 'fully autonomous' expectation. The consensus was observed strongly with regards to the continuous increase on automation in mine operations, with constraining factors such as time horizon proposed, need for human grade control interaction etc. Second round presented similar views, underlining expectations for fully autonomous systems especially for routine processes (trucks, shovels, drilling etc.). Emerging skills gap were repeatedly related to an 'advanced digital literacy' for professionals including programming, mechatronics and AI skills.

- Virtual Reality technology will be used to link all raw materials production functions underpinned by Cyber-Physical Systems (CPS)/Industrial Internet of Things (IIoT).
- Biotechnology will see a huge increase in research and development for extracting metals through biological processes.
- Improvements on professional competences will come about much more on improving 'exploration thinking' rather than data processing – a computer is not the solution to discovering ore.
- Professionals will have to effectively operate in predictive exploration platforms that use analytics, modelling and simulation to identify targets in largely unexplored global regions with minimal (or no) drilling.
- Geophysical and geochemical knowledge in parallel with data sciences, modelling and geographic information system (GIS) skills will be a requirement for geologists working in mining.
- New and improved techniques for waste retreatment and processing will be developed for multiple commodities with multiple applications – dedicated, competent professions will deal exclusively with tailings re-use as well as working together with downstream users for identification of new products and applications.
- Sustainability professional roles will be consolidated including competences in social and environmental performance, Corporate Social Responsibility and post-mine rehabilitation and restoration.
- Future leaders in mining will have greater socio-environmental awareness and will objectively influence how value is perceived in mining.
- Education system will be revolutionized, moving from certification and general preparation to a flexible needs-based education – professionals won't have fixed professions, but lifelong learning, developing a dynamic portfolio of abilities and skills
- Professionals will be more demanded in scientific education (physics, mathematics and chemistry), as well as higher cognitive skills such as creativity and critical thinking, than technological skills.

It is well established that employers focus on different professional development approaches for closing skills gaps. Namely, through re-skilling, up-skilling, mentoring, partnerships with universities and training centres. However, it must be noted that the degree of impact that current and near-

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future trends might have in the future of raw materials companies can also give rise to new operating and business models. Therefore, ongoing feedback of emerging needs in the sector and raw materials employers at large is key for training centres and universities to strategically adapt and timely respond to these needs by adjusting curricula. The MOBI-US mobility programme shall take the skills needs described in this sub-chapter and build its curricula to cover those needs. This will facilitate the integration of raw materials qualified professions into the job market of the ESEE region.

Integrated competency model for employment across the raw materials sector

Based on new knowledge, skills and competences needed for the raw materials sector industries, the INTERMIN project developed a new competency model (a competency model is a framework for defining the skill and knowledge requirements of a job; it is a collection of competencies that jointly define successful job performance) for employment in the raw materials sector. As it is based on the same needs and gaps that are faced by ESEE raw materials related industries, the INTERMIN competency model can be appropriated to MOBI-US. The competency model for the raw materials education industry and, therefore education systems, is as follows (Table 5.3; adapted to the MOBI-US vision). It is based on three areas of the raw materials value chain that are recurrent in this chapter, as well as what WP1 aims: a) Mineral exploration, b) Mineral exploitation and processing and c) Material engineering and recycling. Four different competences groups are considered for each one of these areas: 1) Raw materials competences, 2) Management competences, 3) Conceptual competences and 4) Implementation competences.

Table 5.3: INTERMIN project's competency model for the raw materials sector and competences covered by the MOBI-US network partners

	Mineral exploration	Mineral exploitation and processing	Material engineering and recycling
Raw Materials competences	-Advanced data analytics and simulation modelling in synergy with orebody formation and geological processes in 4D **(AGH, WUST)** -Mineral exploration for new frontier mining e.g.	-Industrial ecology **(UniZg-RGNF, AGH)** -Deep rock engineering/Geomechanics **(UniZg-RGNF, AGH, UNIM, WUST)** -Advanced data analytics and simulation modelling **(UNIM)**	-Investigation and development of new materials and processes **(UniZg-RGNF, AGH, UNIM)** -Advanced data analytics and simulation modelling **(UNIM)**

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	deep sea and space resources **(AGH)**	-Responsible mining due diligence **(UniZg-RGNF, AGH, WUST)**	
Management competences	-Social mechanisms of Community engagement from exploration **(UniZg-RGNF, AGH, UNIM)** -Project management methodologies **(UniZg-RGNF, AGH, UNIM, WUST)**	-Market forecasting and Modelling **(AGH)** -Blockchain embedded smart contracts -Social license to operate' **(AGH, UNIM)** -Project management methodologies **(AGH, UNIM, WUST)**	-Supervision and/or operation of recycling plants **(UniZg-RGNF, AGH, UNIM)** -Project management methodologies **(UniZg-RGNF, AGH, UNIM)**
Conceptual competences	-Systems thinking **(UniZg-RGNF, UNIM)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Advanced/ predictive data analytics, digital twinning and simulation modelling **(WUST)** -Systems engineering -Deep-water engineering **(AGH)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Recycling markets and regulations **(UniZg-RGNF, AGH, UNIM)** -Knowledge of principles of sustainable development **(UniZg-RGNF, AGH)**
Implementation competences	-Application of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-In-situ leaching **(AGH, UNIM)** -Biotechnology **(AGH)** -Nanotechnology. -Deep-water engineering -Electrometallurgy -Environmental and social best practices as well as risk management strategies and plans. **(UniZg-RGNF, AGH, UNIM, WUST)** -Application of principles of sustainable development **(UniZg-RGNF, AGH, UNIM, WUST)**	-Application of principles of sustainable development **(UniZg-RGNF, AGH)**

Supporting the above competence model structure for the raw materials sector is the identified skill and competence gaps in the sector, where these lacking items were compared to the current offered skills to analyse what is missing from today education and how it should be tailored for employers' needs. Skills and competences changes foreseeable in the future are mostly related to

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technological evolution and social and environmental impacts management. Generic health and social tasks are expected to gain increasing importance across the raw materials value chain. Communication, creative thinking and problem-solving skills, sustainability and teamwork are job competencies that are becoming more important across different raw materials professions and organisations.

Skills, within the MOBI-US scope, are most relevant in three distinct, although complementary, areas of the raw materials value chain. The needs of adaptation and emergence of competencies lie in:

a) Mineral exploration

Mineral exploration activities including exploration targeting, sampling, orebody modelling and resources estimation will be affected by the increasing prospects of integrating and processing data from disparate and multi-datasets, which in turn will improve mineral exploration. Machine learning will also become more important with increased applications integrated to more sophisticated 3D visualisation software. These will be able to integrate data acquired with novel technologies such as hyperspectral core imaging and autonomous drilling combined with improved remote sensing technologies.

b) Mining and processing

Mining operations give great amounts of data of different kinds, which are prone to lever digital solutions that can integrate such data. That is the case for the combination of Industrial Internet of Things concepts (Digital twins, 3D simulation and modelling, Machine Learning and AI) with more autonomous mining systems. The consequence of this is/will be a bigger number of decision support systems and remote operating systems, which in turn mean that more raw materials professionals will need to work within these facilities.

Systems engineering and other disciplines will likely translate into more autonomy and lifecycle-oriented systems approaches that will need study and analysis on systems requirements such as decommissioning and mine closure and reclamation. Furthermore, operations will receive increasing attention on end-to-end productivity optimisation, with more integrated decision-making approaches with increased asset management applications

c) Materials engineering and recycling

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Circular economy, which are transversal to the previous two elements of the raw materials sector, requires new skills and competences based on more research efforts for new materials applications, secondary processing technologies and techniques, new business approaches that support circularity as well as new policies and regulations. Due to these areas' needs, where skills and competences will increase, and where professional training will face some gaps, it is needed to identify, control and solve these bottlenecks in advance.

Adding to the above considerations, some assessments of skills needs in the raw materials sector showcase that a decrease in physical and manual skills needs is expected, whilst social and emotional skills and technological skills are expected to be demanded increasingly. The effect of the suggested changes will be felt strongly by lower level occupations and skills - routine work demand is expected to decrease while higher level thinking to anticipate and plan activities is expected to increase.

Specifically, for the three areas mentioned above (exploration, mining and processing, and engineering and recycling), Table 5.4 showcases what are the most affected actions within those fields and what kind of adaptations are needed to solve those bottlenecks:

Table 5.4: Adaptation needs in skills and competences for relevant areas of raw materials and how they are currently supported by MOBI-US network partners.

Field	Most affected areas	Adaptation needs
Mineral exploration	-Targeting, identification and delineation of mineralisation -Exploration design -Field geology -Geo-spatial modelling	-Advanced data analytics and simulation modelling in synergy with better understanding of orebody formation and geological processes in 4D. **(UniZg-RGNF, AGH, UNIM, WUST)** -Knowledge and application of principles of sustainable development **(UNIM, WUST)** -Social mechanisms of community engagement from exploration campaigns downstream **(AGH)** -Mineral exploration for new frontier mining e.g. deep sea and space resources. **(UniZg-RGNF, AGH)**
Mining and processing	-Drill & Blast processes, technical execution – more focus on decision support -Mining geology – less need for on-site presence -Deep rock engineering – more demand for	-Advanced/ predictive data analytics, digital twinning and simulation modelling **(UniZg-RGNF, AGH)** -Systems engineering – managing increased complexity of planning, scheduling and advanced decision-making **(AGH, WUST)** -Business and operating models: more customer-centric approaches, improved market forecasting and

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	geotechnical engineers and modellers -Mining systems – more autonomous systems will be designed and deployed -Asset management -Product marketing -Community engagement towards embedded social responsibility in all mining extraction and processing activities. -Supply chain due diligence – conflict minerals	modelling, and blockchain embedded smart contracts application (UniZg-RGNF, AGH) -Extreme environments: deeper underground mines will require a more complex combination of competencies in geotechnics, hydrogeology, mechatronics and automation. (UniZg-RGNF, AGH) -Business management: deep understanding of 'Social License to Operate', how to implement environmental and social best practices as well as risk management strategies and plans. (UniZg-RGNF, AGH, UNIM, WUST) -Emerging techniques and technologies for extraction: increased demand for in-situ leaching specialists, biotechnology. Open-up of new fields such as nanotechnology. (UniZg-RGNF, AGH, UNIM) -Deep-water engineering skills for designing, implementing and operating deep sea mining projects. (UniZg-RGNF, AGH) -Industrial ecology skills: understand the complex web of interactions raw materials are part of and is a person able to apply tools aligned with the optimisation of the total raw materials cycle, including resources, energy and capital requirements (AGH, UNIM)
Materials engineering and recycling	Processing technologies	-Investigation and development of new materials and processes (UniZg-RGNF, AGH, UNIM) -Strong understanding of circular economy principles and recycling markets. (UniZg-RGNF, AGH) -Regulatory knowledge for secondary raw materials (UNIM) -Supervision and/or operation of recycling plants (UNIM)

The adaptation needs suggested for these three areas shall be taken into account by MOBI-US when building its mobility programmes as well, as these skills and competences are likely to be needed by the future workforce of the raw materials sector related industries. These shall be aligned with the competences list mention before and introduced in the master's curricula offered by the networking universities in the ESEE region. The rise of new competences, coming from the industry needs, will drive the adaptation of the education, and MOBI-US can help its students to be better prepared for such a future market.

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Analysing these data, it is seen that different network partners offer different competences at this moment. It is therefore needed – as is the aim of the project – to offer an integrated set of competences by different institutions so that all can benefit from a wide pool of competencies, seen as a way to support better learning, training and preparation of the future workforce (Figure 5.5). While universities show strong competence offering on mineral exploration and exploitation (areas with long tradition), they are uneven in competences related to more recent developed areas such as mineral processing and recycling.

Figure 5.5: Competences for development by the MOBI-US networking partners that will need to be acquired with the participation of external universities.

International qualification framework for the raw materials sector – the Sectoral Qualifications Framework for the Raw Materials Sector (SQF-RM) approach

Based on its findings (needs for skills, competences, mobility, and others in the raw materials value chain), INTERMIN proposes a new qualification framework that will allow raw materials education and training centres around Europe and the world alike to have a same approach that facilitates and integrates the mobility of students and raw materials professionals and the acquiring of skills, competences and knowledge. This framework, although aimed at international level, will at the same time have a big impact in the EU qualification framework. A framework such as the one proposed can be uptaken by the networking partners universities courses while the same could be extended to other parties involved in the future mobility programs of MOBI-US. This would facilitate the project's goals towards common recognition of skills, competences and knowledge, especially when these are prone to changes in the near future, changes that are not currently

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covered by the EQF framework. This vision would also be able to offer more support to the needs of the raw materials industry in the ESEE region, supported by an integrated competences and skill framework adequate to the current and future needs.

The sectoral qualifications framework for the raw materials sector (SQF-RM) proposed by INTERMIN, improves relevance, transparency and coherence between qualifications along the minerals value chain and the corresponding international recognition in support of the free flow of workers between regions and industry. The SQF-RM is therefore adequate to the MOBI-US masters programmes mobility, where the pilot universities shall showcase how collaboration and interaction among different countries and education establishments, with different offers in skills and competences, can support the future needs bottlenecks that the raw materials industries are likely to face.

INTERMIN's SQF-RM mirrors the EQF (European Qualification Framework), in some respects, since the first has its roots in the latter. One of those is that it still uses a comprehensive competency model for employment across the raw materials sector using a common reference framework of qualifications, expressed as learning outcomes at increasing levels of proficiency (the competency model is suggested in the previous sub-chapter). By mirroring the EQF, the SQF-RM facilitates the adaptation of professional development models, and education and employee training programmes to the requirements of the changing labour market.

The same three areas proposed in the previous sub-chapter are used in this case:

a) Mineral exploration,
b) Mineral extraction and processing,
c) Material engineering and recycling of waste.

To facilitate the definition of key competences for the SQF-RM, INTERMIN uses the following definition of competences: *the necessary prerequisites for meeting complex demands*. The key competences for the SQF-RM combine competences specific to the raw material industry with functional and personal competences required in professional contexts. Table 5.5 shows the seven key competences considered in the SQF-RM, divided among the three areas and their sub-areas:

Table 5.5: Competences considered in the Sectoral Qualification Framework – Raw Materials

Area	Subarea	Competences
-Mineral exploration	-Exploration logistics and planning -Surveying and mapping -Legal and regulatory requirements	-The ability to communicate clearly verbally and in writing

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	-Acquisition, manipulation and analysis of digital terrain data for geological applications -Drilling and sampling techniques -Distribution of elements in rocks, soils, sediments, etc. in relation to mineralization -Geophysical methods applied to exploration -Property and prospect evaluation -Community relations	-Mathematical competence and competences in science and technology -General understanding of sustainability and materials & energy efficiency -General understanding of the raw material value chain -Knowledge and understanding of geological processes in space and time -Digital competence -Knowledge of and commitment to safe working practices
-Mineral extraction and processing	-Permitting -Mine design and planning -Procurement -Mine development -Ore extraction and ore processing -Environmental assessment and management -Waste disposal and site restoration -Cost monitoring -Human Resources management -Corporate social responsibility -Data management / digital technologies -Geotechnics -Mining technologies -Community relations	
-Materials engineering and recycling	-Materials science -Metallography and crystallography -Extractive metallurgy -Metalworking -Collection, crushing and shredding -Separation, melting and purification -Cost monitoring -Human Resources management -Corporate social responsibility	

Based on current skills and future gaps in competences for the raw materials sector, a set of level descriptors for the raw materials education system was suggested. This is based in three areas of high interest: 1) Mineral exploration, 2) Mineral extraction and processing and 3) Material engineering and recycling. Despite having level descriptors for different levels, here are only transcribed the ones that are of importance for the MOBI-US project, i.e., the ones the that are translated to the Masters Programmes levels (Correia et al., 2019).

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Mineral exploration (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of professional geoscientists;
- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between economic effectiveness and data obtention, processing, modelling and simulation;
- the complex dependencies between safety and functionality of the work, economic effectiveness and data obtention, data processing, modelling and simulation;
- communicative English.

General skills – is able to:

- solve complex, non-routine problems of mineral exploration programmes;
- design unique mineral exploration projects in accordance with best practice and the requirements of laws and norms;
- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools;
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motivate a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the provisions of exploration contracts, including the rights and obligations of its participants;
- in depth, the regulations applicable to mineral exploration programmes;

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- the specific norms and requirements of site and property management applicable in the scope of a contract, and the corresponding environmental and social obligations;
- the application of methods and techniques of mineral exploration to improve the processes of mineral extraction and processing.

Occupational skills – is able to:

- design mineral exploration programmes, using different methods and technologies in a manner consistent with budget and client's goals and requirements;
- manages, controls and assesses the implementation of exploration programmes;
- prepare reports of mineral exploration programmes in a manner consistent with existing reporting codes and norms;
- prepare mineral exploration contracts and the corresponding technical documentation.

Occupational social competence – is ready to:

- design and manage mineral exploration programmes;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of exploration programmes;
- assume responsibility for mineral exploration programmes;
- properly assess opportunities and counteract threats in the implementation of exploration programmes.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Geophysical or geochemical exploration programmes;
b) Exploration drilling;
c) Laboratory testing;
d) Classification and evaluation of mineral deposits.

Example of a position requiring qualifications at this level: Senior Exploration Geologist; Senior Project Manager; Mineral Potential Supervisor; Geologists Supervisor.

Mineral extraction and processing (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of professional geoscientists;

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- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between economic effectiveness and data obtention, processing,
- modelling and simulation;
- the complex dependencies between safety and functionality of the work, economic
- effectiveness and data obtention, data processing, modelling and simulation;
- communicative English.

General skills – is able to:

- solve complex, non-routine problems of mineral extraction and/or processing;
- design and implement mineral extraction and/or processing operations in accordance with best practice and the requirements of laws and norms;
- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools,
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motivate a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the provisions of mining contracts, including the rights and obligations of its participants;
- the regulations applicable to mineral extraction and/or processing activities;
- the specific norms and requirements of site and property management applicable in the
- scope of a mining contract, and the corresponding environmental and social obligations.

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Occupational skills – is able to:

- combining different methods and technologies of plan mineral extraction and/or processing
- activities, in a manner consistent with budget and client's goals and requirements; manages, controls and assesses mineral extraction and/or processing activities;
- prepare reports on mineral extraction and/or processing in a manner consistent with existing
- reporting codes and norms.

Occupational social competence – is ready to:

- manage mineral extraction and/or processing activities;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of mineral extraction and/or processing activities;
- assume responsibility for mineral extraction and/or processing activities;
- properly assess opportunities and counteract threats in the implementation of mineral extraction and/or processing activities.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Geophysical or geochemical exploration programmes;
b) Classification and evaluation of mineral deposits.
c) Mining and quarrying;
d) Mineral processing;
e) Management.

Example of a position requiring qualifications at this level: Senior Mine Geologist; Senior Mine Engineer, Environmental Coordinator; Metallurgical Engineer; Mine/Quarry Manager.

Material engineering and recycling (level 7 – Masters degree = EQF)

General knowledge – knows and understands:

- professional and ethical responsibilities of registered professionals;
- the interdependencies of value chains based on mineral raw materials;
- the complex dependencies between safety and functionality of the work, economic effectiveness and data obtention, data processing, modelling and simulation;

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- communicative English.

General skills – is able to:

- solve complex, non-routine problems of metal production and/or recycling;
- design and implement metal production and/or recycling operations in accordance with best practice and the requirements of laws and norms;
- organise working plans and forecasts, and his/her own working time and that of subordinate people;
- train team members, subordinate employees and subcontractors;
- independently perform functions and activities relating to contract management, including:
    - using IT tools,
    - writing and talking in English;
    - measure performance and control deviations;
    - motivate team members and subordinate employees.

General social competence – is ready to:

- take responsibility and demonstrate innovativeness;
- motivate employees to adopt best practices;
- work with and motive a team under pressure;
- implement best practices and establish good interpersonal relations with all relevant stakeholders;
- undertake initiatives aimed at improving effectiveness and financial results.

Occupational knowledge – knows and understands:

- the regulations applicable to metal production and/or recycling activities;
- the specific norms and requirements of site and property management applicable in the
- scope of metal production and/or recycling, and the corresponding environmental and social obligations.

Occupational skills – is able to:

- combining different methods and technologies of metal production and/or recycling activities, in a manner consistent with budget and client's goals and requirements;
- manages, controls and assesses metal production and/or recycling activities;
- prepare reports on metal production and/or recycling in a manner consistent with existing reporting codes and norms.

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Occupational social competence – is ready to:

- manage metal production and/or recycling activities;
- organise the participation of persons with relevant knowledge, qualifications and competence in preparing contracts;
- fully use his/her specialised knowledge and skills in the design, implementation and follow up of metal production and/or recycling activities;
- assume responsibility for metal production and/or recycling activities;
- properly assess opportunities and counteract threats in the implementation of metal production and/or recycling activities.

The holder of an SQF-RM Level 7 qualification works, for the most part, in the following areas:

a) Recycling
b) Smelting.

Example of a position requiring qualifications at this level: Senior Metallurgical Engineer; Senior Materials Engineer, Environmental Coordinator; Recycling Centre Coordinator, Smelting Inspector

The definition of these level descriptors is relevant for MOBI-US, as the project can then, based on these, better adapt their Masters programmes offers and extend the exchange programmes to cover and offer to the students a wide range of skills and competences (both technical and non-technical) that will better prepare the students for the market and that are inline with the industry needs as well as with European policies suggestions and requirements. This will in turn strengthen the raw materials sector as a whole. The ESEE region can greatly benefit from following such an approach.

The above skills and competences listed shall be taken into account by the university partners when drafting the masters programmes and mobility and shall, therefore, put in focus a mix of skills offered by different entities, that can help to cover has much skills gaps as possible.

Only with a common and shared approach will be possible for the project's aim to be concretized. The mobility program shall, after the MOBI-US project lifetime, extend to other universities that are offering/can offer/will offer skills and competences that the project networking universities are not capable of providing currently. One other option to complete the offer of required competences would be to involve raw materials training centres in the process, following the principle that, those too, would use the SQF-RM.

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5.4. Conclusions and recommendations

The analysis and knowledge transfer of the INTERMIN project on the European qualification framework, the skill and competences catalogue as well as the analysis on skills gaps for the raw materials sector lead to the development of a set of recommendations and suggestions for the application of such outcomes in MOBI-US that shall support and lead to a proper implementation of the project's goals in the ESEE region. Such recommendations are based on four main topics (in accordance with the objective of task 1.5 and with the referred projects):

- The skills catalogue developed for the raw materials sector (based on INTERMIN's D1.1)
- A report on skill gaps in the sector (Based on INTERMIN's D2.1)
- An integrated competency model for employment across the raw materials sector (based on INTERMIN's D2.2), and
- The International qualification framework for the raw materials sector (based on INTERMIN's D3.1).

The main conclusions and recommendations, for each of the previous items are specified next. MOBI-US shall implement and follow these as they are in line with policy and industry requirements for the future of the raw materials sector in the ESEE regions (also in line with the remaining deliverables of MOBI-US Work Package 1).

The skills catalogue developed for the raw materials sector

1) MOBI-US shall recur to INTERMIN's public online database to help find partner institutions - matchmaking. The importance for MOBI-US lies in the list of skills offered by the ESEE universities and training centres. The database offers the perfect pool of potential candidates for the extension of the mobility programs.
2) MOBI-US shall ensure a minimal threshold for any definition applied within the project. This threshold will not only ensure clarity for students and course/programme coordinators across countries but will also ensure that any student can be certain that the skills and competences he or she will acquire during his or her exchange period can be accepted as valid ECTs.
3) The MOBI-US program shall promise to be an equal opportunity program. A declaration signed by all network partners shall be signed. A survey can go hand-in-hand with the equality approach to better understand and steer the mobility programs in order to achieve a fruitful outcome.

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4) It is of relevance for MOBI-US to guarantee that the exchange and mobility programs will follow the value of T-shape professionals as they are an attractive and high demand commodity on the job market. The T-shape approach shall improve on some requirements including, but not limited to, new systemic innovations in areas of waste reduction, recycling, material efficiency and residue utilization. It is also necessary that professionals have a deep understanding of the raw materials system and the entire value chain.
5) All of the new skills defined within INTERMIN have some degree of importance in the current and future panorama for the raw materials sector and should, therefore, be fostered in the education and training of raw materials professionals. In the light of the MOBI-US mobility programs, these skills should take major importance.

Skill gaps in the raw materials sector

1) MOBI-US shall take into account the needs (skill gaps) of the raw materials sector in the short, medium and long-terms and adapt its mobility programs to cover these needs.
2) MOBI-US shall monitor ongoing feedback of emerging needs in the sector and raw materials employers. The mobility programme can then be strategically adapted to be able to respond to these needs by adjusting curricula offered by the networking partners. It thus necessary that MOBI-US establishes a close relation with ESEE raw materials industries.

Integrated competency model for employment across the raw materials sector

1) MOBI-US shall guide the development and implementation of the mobility programme from INTERMIN's competency model. As it is based on the same needs and gaps that are faced by ESEE industries, the INTERMIN competency model can be appropriated to MOBI-US. The competency model is based on three areas of the raw materials value chain: 1) Mineral exploration, 2) Mineral exploitation and processing and 3) Material engineering and recycling. Four different competence groups are considered for each one of these areas: 1) Raw materials competences, 2) Management competences, 3) Conceptual competences, and 4) implementation competences.
2) MOBI-US shall try to solve the lack of competencies and the missing adaptation needs envisaged for the future of these three areas.

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International qualification framework for the raw materials sector

1) MOBI-US can develop its new mobility programme in line with INTERMIN's proposed qualification framework: "sectoral qualifications framework for the raw materials sector" (SQF-RM). This framework, although aimed at international level, will at the same time have a big impact in the EU qualification framework. A framework such as the one proposed can be uptaken by the mentoring partners universities while the same could be extended to other parties involved in the future mobility programs of MOBI-US. This would facilitate the project's goals towards common recognition of skills, competences, and knowledge, especially when these are prone to changes in the near future, changes that are not currently covered by the EQF framework.
2) The SQF-RM propose new level descriptors for master programmes, which MOBI-US masters programmes shall follow.
3) The mobility program shall, after the MOBI-US project lifetime, extend to other universities that are offering/can offer/will offer skills and competences that the project networking universities are not capable of providing currently. One other option to complete the offer of required competences would be to involve raw materials training centres in the process.

The above conclusions/suggestions shall be taken into consideration within WP1 and transferred to other work packages during the MOBI-US implementation. They shall continue to be relevant even the project funding period is over. All the actions call for an integrated assessment by the networking partners that shall be supported by finding and matchmaking with new partners. The MOBI-US workshops will prove important in this regard.

A last consideration falls on the need to keep screening the raw materials sector for its development, needs, skill gaps and other aspects of relevance. Ways to do this screening and at the same time involve relevant stakeholders are the base of foresight studies, which shall be applied in the future – either during or after the project. Proposed foresight methods to keep MOBI-US in line with the raw materials sector facets include:

1) Desk research,
2) Delphi Surveys,
3) Focus groups.

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5.5. References

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